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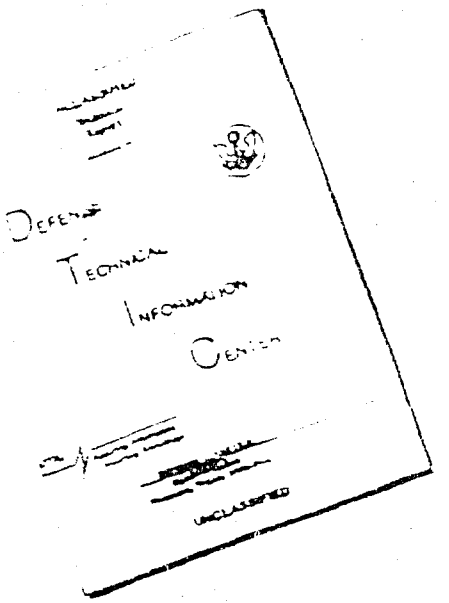

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NORMAL SHOCK WAVE PARAMETERS IN EQUILIBRIUM AIR

By: Charles E. Wittliff
James T. Curtis

CAL Report No. CAL-111
November 1961

CORNELL AERONAUTICAL LABORATORY, INC.
OF CORNELL UNIVERSITY, BUFFALO 21, N. Y.

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FOREWORD

This report contains the results of an extensive series of normal shock wave calculations for equilibrium air performed under the direction of the authors at the Cornell Aeronautical Laboratory, Inc. That portion of the calculations relative to the "corridor of continuous flight" were performed for the Eclipse-Pioneer Division of the Bendix Aviation Corporation under Purchase Order No. 34-390785-G-48 (U. S. Air Force Prime Contract No. AF 33(616)-6579) and were reported in CAL Report No. AF-1429-P-1. Additional calculations pertinent to ballistic missile re-entry trajectories were made under Contract No. DA-30-069-509-ORD-3117 with the U. S. Army Rocket and Guided Missile Agency. The remainder of the calculations and the preparation of the present report were funded by the Cornell Aeronautical Laboratory, Inc.

The authors sincerely thank Dr. Russell E. Duff of the Los Alamos Scientific Laboratory for making available the IBM-computer program used in the present work. Grateful acknowledgement is due also to Mr. F. E. Butler of the Computer Services Section who handled the IBM-704 calculations. Finally, the authors wish to thank the various personnel of the Aerodynamic Research Department who contributed additional calculations and valuable assistance in preparing the tables and graphs.

ABSTRACT

This report presents tables and graphs of normal shock wave parameters for equilibrium air. Composition of the air behind the shock is also tabulated. The results cover the range of velocities from 2000 fps to 26,000 fps in increments of 1000 fps and altitudes from sea level to 300,000 ft at 10,000-ft intervals. The 1959 ARDC model atmosphere has been used to specify ambient conditions ahead of the shock. An effective specific heat ratio, γ_e, has been tabulated which permits solution of oblique shock waves according to the method given in NASA TR R-63.

TABLE OF CONTENTS

SYMBOLS

a	speed of sound, ft/sec
E	internal energy, ft-lb/slug
H	enthalpy, ft-lb/slug $= ft^2/sec^2$
L	reference length (Table I), feet
M	Mach number
P	pressure, psfa
R	gas constant, ft-lb/slug-°R
Re	Reynolds number, $\rho VL/\mu$
T	temperature, °R
V	velocity, ft/sec
Z	compressibility factor
β	dimensionless enthalpy parameter, Eq. (19)
γ	specific heat ratio
λ	mean-free-path, feet
μ	viscosity, slugs/ft-sec
ρ	density, slugs/cu.ft

Subscripts

1	conditions ahead of shock wave
2	conditions behind shock wave
e	effective, applied to specific heat ratio, Eq. (26)
T	stagnation-point conditions

INTRODUCTION

As indicated in Refs. 1 to 8, there have been published a number of reports of real-air solutions for normal shock waves at hypersonic speeds. Although these reports have found widespread use, it was felt that a more extensive compilation than now exists would prove worthwhile. Hence, calculations undertaken for other programs (see for example Ref. 9) were extended in order to provide a comprehensive tabulation of normal-shock-wave solutions for equilibrium air. Also included here are certain conditions at the stagnation-point behind the normal shock. In addition, the gas composition behind the shock is tabulated. The most recent 1959 ARDC model atmosphere[10] has been used to specify the ambient conditions ahead of the shock wave, and argon has been included in the composition of the air model used. To provide a useful tabulation, velocity and altitude have been taken as the independent parameters, and the increments (1000 fps in velocity and 10,000 ft in altitude) have been chosen to provide convenient interpolation.

The solutions have been obtained using an IBM-704 computer program made available by Dr. Russell E. Duff of the Los Alamos Scientific Laboratory. In this procedure, the machine is supplied with initial conditions and estimates of the conditions behind the shock. Because the composition behind the shock is computed at each step of the program, it is possible to use an arbitrarily complex model for air. The air composition behind the shock was varied somewhat with initial velocity to prevent the machine from seeking negligibly small concentrations of certain species at low velocities.

The results are presented as tables and graphs of the normal shock wave parameters, ρ_2/ρ_1, p_2/p_1, T_2/T_1, Z_2 and H_2/H_1. Also, certain conditions at a stagnation-point behind the normal shock are given; namely, H_{T_2}/H_1, p_{T_2}/p_1, and T_{T_2}/T_1.

The solution to oblique shock waves can be obtained by the method developed by Trimpi and Jones[11]. To facilitate the application of the present results to oblique shock calculations by their method, the effective specific heat ratio, γ_e, has been tabulated also. Use of Ref. 11 and the present report permits the solution of any oblique shock wave whose normal velocity component falls within the range of the present tables.

In the present report the air behind the shock has been assumed to be in thermal and chemical equilibrium. There are, of course, two extreme states for the region behind a normal shock wave at hypersonic speeds; they are thermo-chemical equilibrium as assumed here and the chemically "frozen" state for which ideal gas tables apply. At high altitudes and high velocities, both states can exist downstream of a shock wave. The gas will be "frozen" immediately downstream of a shock wave, but will pass through a relaxation zone and emerge in thermodynamic and chemical equilibrium. The nonequilibrium region has been the object of several studies (for example Refs. 12-15) which have resulted in computer programs to obtain numerical solutions.

NORMAL SHOCK WAVE SOLUTION

Basic Assumptions

The assumptions contained in the present work are those commonly

made in obtaining normal shock wave solutions for real-air in thermodynamic equilibrium. They are that: the flow is uniform and steady; the air is a homogeneous mixture of ideal gases each obeying its own equation of state; the flow is adiabatic and inviscid; the flow is a continuum; thermo-chemical equilibrium exists behind the shock wave. In addition, the atmospheric properties as given by the 1959 ARDC model atmosphere[10] exist ahead of the shock, and the composition of the air ahead of the shock is taken as 78.09% nitrogen, 20.98% oxygen, and 0.93% argon.

Conservation Equations

The equations for the conservation of mass, momentum, and energy across a normal shock wave are

Mass $$\rho_1 V_1 = \rho_2 V_2 \tag{1}$$

Momentum $$p_1 + \rho_1 V_1^2 = p_2 + \rho_2 V_2^2 \tag{2}$$

Energy $$H_1 + \frac{1}{2} V_1^2 = H_2 + \frac{1}{2} V_2^2 \tag{3}$$

where the subscripts 1 and 2 denote the conditions ahead of and behind the shock, respectively.

Ahead of the shock the air is at low temperature and the ideal-gas relations for equation of state and speed of sound are applicable

$$p_1 = \rho_1 R T_1 \tag{4}$$

$$a_1^2 = \gamma_1 R T_1 = \frac{\gamma_1 p_1}{\rho_1} \tag{5}$$

where $\gamma_1 = 1.4$.

The other information required to obtain the solution for a normal shock wave is the equation of state of the gas behind the shock. This is usually represented by tables of the thermodynamic properties of air at high temperature, e.g., Refs. 16-21.

Rankine-Hugoniot Relations

The velocities may be eliminated from the conservation equations (1-3), and relationships obtained which contain only the thermodynamic properties. These are the well-known Rankine-Hugoniot relations[22] which may be written

$$\frac{1}{2}(p_2 - p_1)\left(\frac{1}{\rho_1} + \frac{1}{\rho_2}\right) = (H_2 - H_1) \tag{6}$$

or, using $H = E + \frac{p}{\rho}$, as

$$\frac{1}{2}(p_1 + p_2)\left(\frac{1}{\rho_1} - \frac{1}{\rho_2}\right) = (E_2 - E_1) \tag{7}$$

These relations hold for both real and ideal gases since they do not introduce the equation of state.

Once a solution to either of these equations has been obtained, the initial velocity may be found from Eqs. (1) and (2) as

$$V_1^2 = \frac{p_1}{\rho_1}\,\frac{p_2/p_1 - 1}{1 - \rho_1/\rho_2} = \frac{p_1}{\rho_1}\,\frac{\rho_2}{\rho_1}\,\frac{p_2/p_1 - 1}{\rho_2/\rho_1 - 1} \tag{8}$$

Introducing the equation of state for the gas ahead of the shock, Eq. (4), and the expression for the speed of sound, Eq. (5), the initial Mach number is

$$M_1^2 = \frac{1}{\gamma_1}\,\frac{p_2/p_1 - 1}{1 - \rho_1/\rho_2} = \frac{1}{\gamma_1}\,\frac{\rho_2}{\rho_1}\,\frac{p_2/p_1 - 1}{\rho_2/\rho_1 - 1} \tag{9}$$

Solution for Real Air

There are several approaches to solving the Rankine-Hugoniot relation, say Eq. (6), for real air in thermodynamic equilibrium. If the ambient conditions p_1, ρ_1, T_1, and H_1, and the initial velocity, V_1, are specified, an iterative procedure must be used. This involves estimating two of the conditions behind the shock, say p_2 and T_2, determining the other thermodynamic properties from tables (Refs. 16-20), and calculating both sides of Eq. (6) and the right side of Eq. (8). This process is repeated until the left and right sides of Eq. (6) are equal and the specified velocity is obtained from Eq. (8) to within the desired accuracy. This method may be used manually or with a high-speed computing machine if the thermodynamic tables are stored in the computer.

An alternate approach is to specify the initial ambient conditions and the temperature behind the shock, but not the initial velocity. Then only Eq. (6) must be solved by iteration after which the velocity is calculated from Eq. (8). This technique has been used in Ref. 8, for example.

For the case where the gas ahead of the shock is ideal, as we have assumed here, there exists a procedure for obtaining a solution in closed form. If the equilibrium thermodynamic state behind the shock and the initial temperature ahead of the shock are specified, the Rankine-Hugoniot relation, Eq. (6), reduces to a quadratic equation in either p_1 or ρ_1, or in their ratios to the known conditions behind the shock. The exact solution for the density ratio, ρ_1 / ρ_2, has been derived independently by Hochstim[5] and Golian[23*]. The quadratic equation and the

* Actually, Hochstim derives the equation and gives a solution for the ratio ρ_2 / ρ_1, whereas Golian finds ρ_1 / ρ_2.

solution for ρ_1 / ρ_2 are

$$\left(\frac{\rho_1}{\rho_2}\right)^2 + \left[1 + \frac{2(H_2 - H_1) - z_2 RT_2}{RT_1}\right]\left(\frac{\rho_1}{\rho_2}\right) - \frac{z_2 T_2}{T_1} = 0 \tag{10}$$

$$\left(\frac{\rho_1}{\rho_2}\right) = -\frac{1}{2}\left[1 + \frac{2(H_2 - H_1) - z_2 RT_2}{RT_1}\right] + \sqrt{\frac{1}{4}\left[1 + \frac{2(H_2 + H_1) - z_2 RT_2}{RT_1}\right]^2 + \frac{z_2 T_2}{T_1}} \tag{11}$$

Similarly, for the pressure ratio, p_1/p_2, one can derive from Eq. (6) the result

$$\left(\frac{p_1}{p_2}\right)^2 + \left[\frac{2(H_2 - H_1) + RT_1}{z_2 RT_2} - 1\right]\left(\frac{p_1}{p_2}\right) - \frac{T_1}{z_2 T_2} = 0 \tag{12}$$

$$\frac{p_1}{p_2} = -\frac{1}{2}\left[\frac{2(H_2 - H_1) + RT_1}{z_2 RT_2} - 1\right] + \sqrt{\frac{1}{4}\left[\frac{2(H_2 - H_1) + RT_1}{z_2 RT_2} - 1\right]^2 + \frac{T_1}{z_2 T_2}} \tag{13}$$

Although this procedure results in an exact solution, it is not used widely because the equilibrium state behind the shock rather than ahead of the shock is the primary independent condition. However, it is a convenient means of checking the accuracy of iterative solutions.

COMPUTATIONAL PROGRAM

Normal Shock Wave Calculations

The computational program has two phases: the calculation of conditions immediately behind a normal shock and the calculation of conditions at the stagnation point. The latter was added at CAL to Duff's original program. In the computer program the machine is supplied with the temperature, pressure and composition of the gas ahead of a shock of

specified speed and also with initial estimates of the same quantities behind the shock. In addition, the thermodynamic properties of the reactant and product gases are read into the machine by means of "thermo-fit" cards which supply the coefficients in polynomial equations fitted to the tabulated functions*. The thermo-fit equations for the monatomic gases were obtained by Duff. The thermo-fit equations for the diatomic gases were taken from the work of Fickett and Cowan[24]. For both cases, it was necessary to use two sets of cards covering respectively the temperature range 500°K to 3000°K and 3000°K to 12,000°K.

The computing program was essentially as follows:
The equilibrium composition corresponding to the assumed temperature and pressure are calculated by an iterative solution of Brinckley's matrix equations[25,26]. With a tentative chemistry established, the equation of state is known and the specific enthalpy H_2 and density ρ_2 may be computed. These thermodynamic variables are then substituted into the Hugoniot equation

$$\frac{H_2 - H_1}{RT_1} = \frac{1}{2}\left(\frac{p_2}{p_1} - 1\right)\left(1 + \frac{\rho_1}{\rho_2}\right) \tag{16}$$

to compute an improved value for the pressure ratio p_2/p_1, which is used to start a new cycle. When the relative change in p_2/p_1 per cycle falls to 10^{-6}, the pressure iteration is stopped and the shock speed is computed from the equation

$$V_1^2 = \frac{1}{\rho_1^2}\,\frac{p_2 - p_1}{\frac{1}{\rho_1} - \frac{1}{\rho_2}} \tag{17}$$

* These are tabulated in the Appendix.

At this point, one has the option of stopping the calculation and printing out V_1 and the other variables as functions of the temperature behind the shock.

For the present purpose, however, it was more convenient to vary T_2 until the specified shock speed was obtained. Thus, the whole set of calculations outlined above was repeated with different temperatures until the calculated shock speed agreed with that specified within an error of 1 cm sec^{-1}.

The convergence of the multiply-iterative calculational scheme described above was found to depend on the concentrations of the independent components used in the Brinckley scheme to describe the composition behind the shock. A mixture of thirteen chemical species, N, O, A, e^-, N_2, N_2^+, O_2, O_2^+, NO, NO^+, N^+, O^+, O^-, with N, O, A, e^- as the independent components was assumed to exist behind the strongest shocks. This model proved generally satisfactory at shock speeds of 14,000 ft per sec and above, but below this speed the concentration of electrons became too low (mole fraction $< 10^{-5}$) for convergence. Thus, it was necessary at this point to drop ionization leaving an air model consisting of N_2, O_2, A, N, O, and NO with the molecules N_2, O_2, A as the independent species. Further decreases in shock speed lowered T_2 below 3000°K so that it was necessary to shift to the low-range "thermo-fit" cards. Finally, at very low shock Mach numbers, the concentrations of nitrogen and nitric oxide became too low for the machine to handle and it was necessary to change to a four-species model including only N_2, O_2, A, and O. Actually, the concentration of atomic oxygen is essentially negligible in

in this range, but its inclusion was necessary to preserve the logic of the calculation.

The air models described above were used in the regions mapped in Fig. 1. In some cases a model was used to compute one or two points beyond the indicated boundaries. In these cases of overlapping data preference was given to that arising from the more complex air model. Where the number of species was the same, preference was given to the computation which used the right thermo-fit cards for the indicated T_2.

This overlap gave the opportunity for comparison of the air models employed in the program. Table 1 gives the values of $\Delta T_2/T_{2_{average}}$ and $\Delta p_2/p_{2_{average}}$ computed from the overlapping data at each of the numbered boundary points indicated in Fig 1, where ΔT_2 and Δp_2 are the differences between the two calculations. It is clear from the minuteness of the relative errors indicated by Table 1 that the air models and their boundaries are reasonably accurate.

Another source of error is the thermodynamic functions. Fickett and Cowan[24] forced their approximate calculations to agree with those performed at the Bureau of Standards[27] over the range $3000°K \leq T \leq 5000°K$. The necessary corrections when extrapolated to 12,000°K amounted to less than 2%. The greatest r-m-s error in fitting cubic equations to the tabulated data was in the low range thermo-fit cards and amounted to 0.26% for NO. No information about the accuracy of the fits for the atomic constituents is available to the authors.

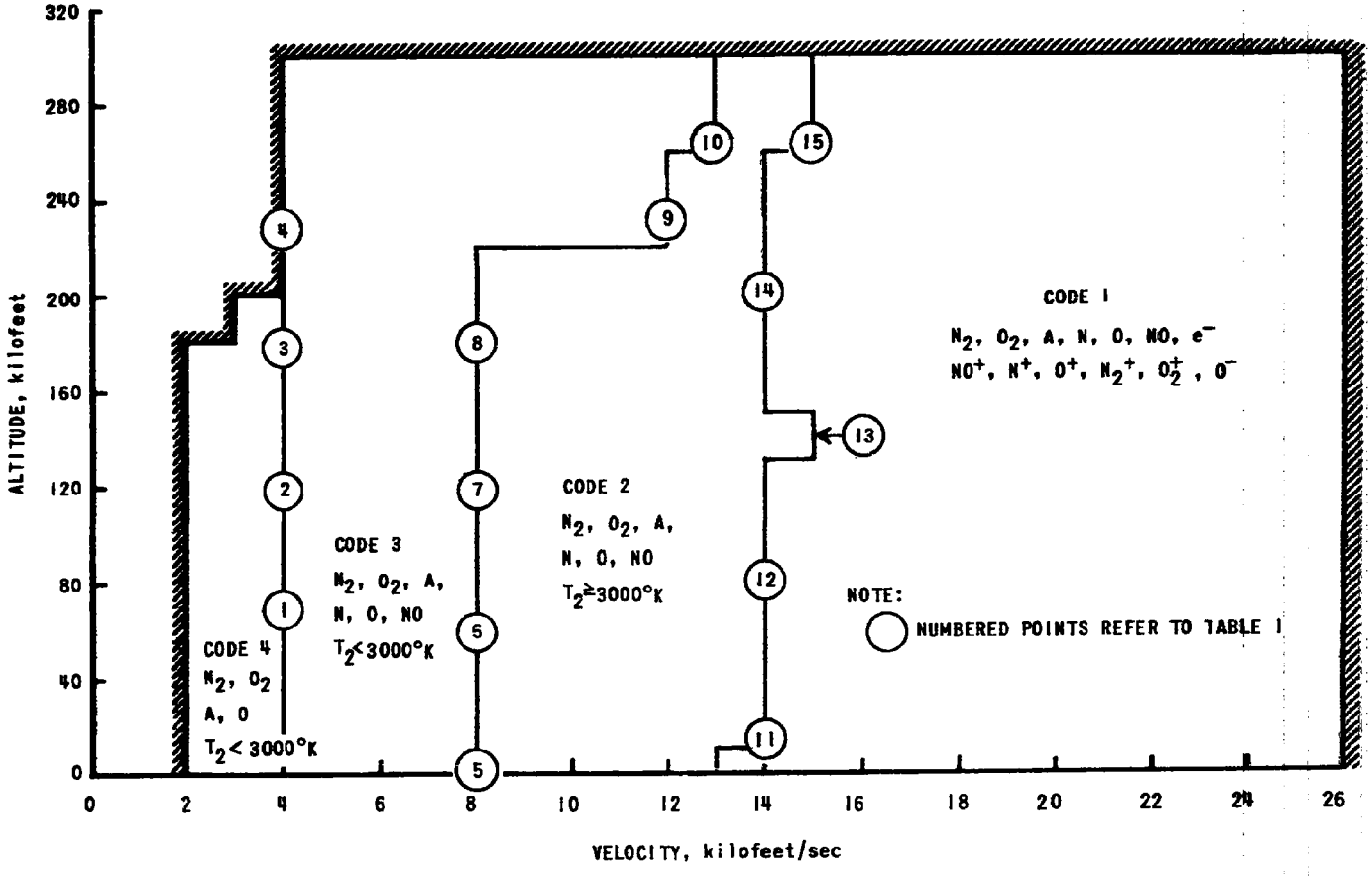

Figure I AIR MODELS ASSUMED FOR SPECIES BEHIND NORMAL SHOCK WAVE

TABLE 1

TYPICAL RELATIVE ERRORS AT MODEL BOUNDARIES
FOR POSITION OF POINTS SEE FIG. 1

Point No.	$\lvert\Delta T_2\rvert / (T_2)$ avg.	$\lvert\Delta p_2\rvert / (p_2)$ avg.
1	2.239×10^{-5}	1.132×10^{-5}
2	3.254×10^{-5}	1.247×10^{-5}
3	5.301×10^{-5}	2.634×10^{-5}
4	- - - -	- - - -
5	90.273×10^{-5}	22.514×10^{-5}
6	115.624×10^{-5}	23.72×10^{-5}
7	109.524×10^{-5}	23.985×10^{-5}
8	109.110×10^{-5}	25.154×10^{-5}
9	15.723×10^{-5}	0
10	3.305×10^{-5}	0
11	7.284×10^{-5}	0
12	6.263×10^{-5}	0
13	5.962×10^{-5}	7.704×10^{-5}
14	13.898×10^{-5}	7.732×10^{-5}
15	7.375×10^{-5}	2.513×10^{-5}

Stagnation-Point Calculations

The procedure adopted for calculating the stagnation point values T_{T_2}, p_{T_2} is based upon the observation that T_{T_2} differs little from T_2 and consequently the compressibility factor Z_2 is nearly constant along the stagnation streamline.

Essentially, the flow chemistry was frozen at the equilibrium condition immediately behind the shock. Thus, one may assume an isentropic compression described by the equation

$$dH = \frac{1}{\rho}\, dp \tag{18}$$

or, on defining

$$\beta \equiv \frac{H}{\mathcal{Z}RT} \tag{19}$$

by

$$\beta \frac{dH}{H} = \frac{dp}{p} \tag{20}$$

It is now assumed that β = constant allowing the integration of Eq. (20) in the form

$$\frac{p_{T_2}}{p_2} = \left(\frac{H_{T_2}}{H_2}\right)^{\beta} = \left(1 + \frac{V_2^2}{2H_2}\right)^{\beta} \tag{21}$$

or, to the same degree of approximation

$$\frac{p_{T_2}}{p_2} = \left(1 + \frac{\beta V_2^2}{2H_2}\right) \tag{22}$$

This equation has been used to calculate p_{T_2}. Note, however, that by eliminating β, Eq. (22) can be written as

$$\frac{p_{T_2}}{p_1} = 1 + \gamma_1 M_1^2 \left(1 - \frac{1}{2\rho_2/\rho_1}\right) \tag{23}$$

which is identical to Bernoulli's equation for incompressible flow. This, of course, is to be expected since we have in essence assumed the density to be constant along the stagnation streamline.

The stagnation temperature has been determined from the stagnation enthalpy, since, by assumption, c_p is constant in this region. Thus

$$\frac{T_{T_2}}{T_2} = \frac{H_{T_2}}{H_2} = 1 + \frac{V_2^2}{2H_2} \tag{24}$$

The accuracy of the calculated values of p_{T_2} and T_{T_2} have been spot-checked using Eq. (23) and by calculating a real-gas isentropic compression from H_2 to H_{T_2} (which is known a priori) using a Mollier diagram for air. The maximum differences amounted to no more than 2.3% in p_{T_2} and 1% in T_{T_2}, and in general were much less than these values.

1959 ARDC MODEL ATMOSPHERE

The 1959 model atmosphere[10] on which these tables are based is summarized in Table I*. This new model is an extension and revision of the 1956 model. The revisions were undertaken after satellite data revealed that high altitude densities were considerably larger than had hitherto been expected. Below a geometric altitude of approximately 173,500 feet, the two atmospheric models are identical. Above that altitude the new model has a higher density (higher by a factor of 10 at 300,000 feet) and a lower temperature (a difference of 30°K at 195,300 feet). In the 1959 model, as in its predecessor, the molecular weight of air is taken to be constant up to 300,000 feet, where it begins to decrease owing to dissociation and natural stratifications.

* In Tables I and III the numbers in parentheses indicate the power of 10 that the tabulated number is to be multiplied by.

RESULTS

Normal Shock Wave Parameters

The normal shock wave parameters that have been selected for presentation here are:

ρ_2/ρ_1	,	the density ratio across the shock
p_2/p_1	,	the pressure ratio across the shock
T_2/T_1	,	the temperature ratio across the shock
Z_2	,	the compressibility factor behind the shock
H_2/H_1	,	the enthalpy ratio across the shock
H_{T_2}/H_1	,	the ratio of total enthalpy behind the shock to static enthalpy ahead of the shock*
p_{T_2}/p_1	,	the ratio of stagnation pressure behind the shock to freestream static pressure
T_{T_2}/T_1	,	the ratio of stagnation temperature behind the shock to freestream static temperature
γ_e	,	the effective specific-heat ratio as defined in Eq. (26) on page 19

The velocity behind the shock, V_2, can be determined easily from the continuity equation, Eq. (1), that is

$$V_2 = \frac{V_1}{\rho_2/\rho_1} \tag{25}$$

By using thermodynamic charts (AVCO's Mollier Diagram for Air, Ref. 5) or tables (e.g., Ref. 16), the speed of sound, a_2, may be determined knowing p_2, T_2, and ρ_2. Then the Mach number behind the shock, M_2,

---

* Note that from the conservation of energy $H_{T_2} = H_{T_1} = H_1 + 1/2\ V_1^2$. Hence, this can be determined a priori. The ratio H_{T_2}/H_1 is tabulated only for convenience.

can be calculated. The density at the stagnation point downstream of the shock can be found from thermodynamic tables for air knowing H_{T_2}, p_{T_2}, and T_{T_2}. The use of the effective specific heat ratio, γ_e, to obtain oblique shock wave solutions is described in the next section of the report.

Tables

The normal shock wave parameters listed above are tabulated as functions of free-stream velocity, V_1, in Table II. Each page of the table is for a specific altitude. The free-stream Mach number, M_1, is also listed. The ambient pressure, density, temperature, enthalpy, and sonic speed for each altitude are also given at the top of each table.

The gas composition behind the shock wave is presented in Table III with the species concentrations given as mole fractions. These are listed for the various species behind the shock as a function of free-stream velocity. Again each page of the table represents a single altitude.

Graphs

Graphs of the following parameters are given at the end of the report:

$$\frac{\rho_2}{\rho_1} \quad \frac{p_2}{p_1} \quad \frac{T_2}{T_1} \quad \frac{H_2}{H_1} \quad \frac{p_{T_2}}{p_1} \quad \frac{T_{T_2}}{T_1}$$

The presentation in the graphs differs from that normally used for normal shock wave parameters. Generally, the parameters have been plotted as a function of velocity or Mach number for constant altitude; e.g., Refs. 1, 4, 7, and 8. Such a presentation permits direct reading of the desired velocity; however, interpolation between altitudes is sometimes awkward. In the present report the parameters are plotted as a function of altitude for constant velocity. The nature of the resulting graph permits direct reading of the altitude and simple interpolation for the velocity which is

plotted in 1000-fps intervals. It should be noted that only in Graph 1 of the density ratio, ρ_2/ρ_1, do any of the velocity curves cross. There the curves for 13,000 fps and 14,000 fps cross the 11,000 fps and 12,000 fps curves. This behavior of the density ratio is related to oxygen dissociation occurring behind the shock.

Comparison of the Results with Other Solutions

In making a quantitative comparison of the present results with other calculations, the density ratio ρ_2/ρ_1, was selected as the parameter to be compared. The comparisons were made over the Mach number range 10 to 17 which includes the region where oxygen dissociation occurs behind the normal shock. The comparison was made graphically by plotting ρ_2/ρ_1 versus M_1 for several altitudes. Altitudes above 100,000 feet have not been compared because of increasing differences in ambient conditions for the various atmospheric models. The specific altitudes and references compared are listed in the following table.

TABLE 2

ALTITUDES AND REFERENCES COMPARED WITH PRESENT RESULTS

Altitude	Reference
Sea Level	Bond[1], Romig[2], Feldman[4], and Batchelder[7]
82,020 ft*	Huber[8]
100,000 ft	Bond[1], Moeckel[3], Feldman[4], and Batchelder[7]

* Compared with present results for 80,000 ft: the free-stream temperatures are equal for 80,000 and 82,020 ft and the atmospheric pressure differs by only 1.6%.

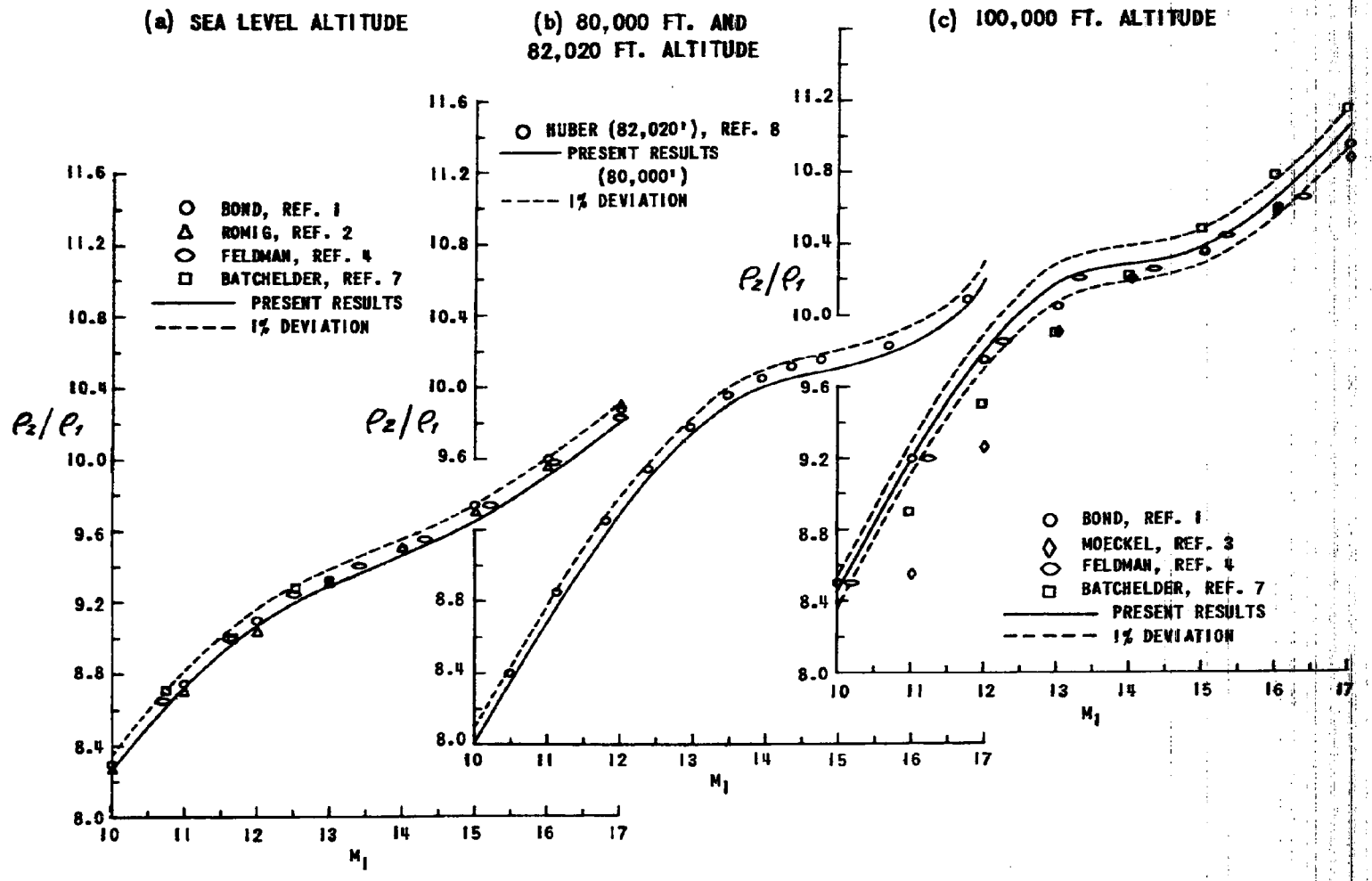

Figure 2 COMPARISON OF DENSITY RATIO

The comparison at sea level showed agreement of 1% or better for Mach number range 10 to 17; the average difference is about 1/2%, Fig. 2a. This is exceptionally good considering that the data being compared with the present results were read from graphs. The data, however, were consistently higher than the present work except for the solution of Ref. 2 from Mach 10 to 12.5. The small, but consistent, discrepancy may be attributable to the inclusion of argon in the air model of the present work or to differences in the thermodynamic properties.

Huber's results at 82,020 feet are also consistently higher than the present results for 80,000 feet, Fig. 2b. Again, however, the difference is always less than 1% and averages about 1/2% in the Mach number range 10 to 17. The small difference in atmospheric pressure at these two altitudes (1.6%) should not introduce any significant error in the comparison of density ratio.

At 100,000 feet altitude the data being compared with the present results show considerably more scatter than at sea level, Fig. 2c. The solutions by Bond[1] and Feldman[4] show the greatest consistency of agreement generally to within 1%; however, the differences are sometimes as large as 2%. Moeckel's results[3] are well below the other data for Mach numbers below 14. At Mach 14 to 17 they agree to better than 2%. The solutions reported by Batchelder et al[7] do not follow the trend consistently, being low below Mach 14 and high above Mach 14.

APPLICATION TO OBLIQUE SHOCK WAVES

A method of solution for an oblique shock wave attached to a surface at arbitrary angle of attack, sweep and dihedral has been given by Trimpi

and Jones in Ref. 11. The extensive tabulation of the results presented in that reference are applicable to any real gas in thermodynamic equilibrium. To use their results one requires a knowledge of the effective specific-heat ratio γ_e, as a function of Mach number for a normal shock wave in the particular gas of interest. This effective specific-heat ratio, which is defined as

$$\gamma_e \equiv 2\frac{M_1^{-2}-1}{\left(\frac{1}{p_2/p_1}-1\right)} - 1 \qquad (26)$$

has been calculated for all the normal shock wave solutions reported herein. Thus the present results can be used in conjunction with Ref. 11 to determine conditions behind oblique waves for a wide range of velocities and flow deflections in the earth's atmosphere.

The procedure for obtaining an oblique shock wave solution using the effective value of specific-heat ratio, γ_e, is thoroughly described in Ref. 11 and will not be repeated here.

SUMMARY

Solutions for normal shock waves in air have been computed for velocities from 2000 fps to 26,000 fps and altitudes from sea level to 300,000 feet. The 1959 ARDC Model Atmosphere has been used to define the ambient conditions ahead of the shock wave. In addition to flow conditions just behind a normal shock wave, the isentropic compression to a stagnation point has been calculated under the assumption of constant density behind the shock. Thermodynamic equilibrium is assumed in all calculations.

The results are presented in tabular and graphical form. In addition to the normal-shock and stagnation-point parameters, the composition of the air behind the shock has been tabulated. Also included in the tables is the effective specific-heat ratio, γ_e, which can be used with Ref. 11 to obtain solutions to oblique shock waves.

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APPENDIX

POLYNOMIAL APPROXIMATIONS FOR THERMODYNAMIC FUNCTIONS

The use of the thermo-fit cards has been described in the text. These cards contain the coefficients of polynomial equations for enthalpy or free-energy as a function of temperature. In as much as the source of the thermodynamic properties of high temperature air is pertinent to normal shock wave calculations, the equations utilized in the present work are given here.

Ahead of the normal shock the air is a mixture of nitrogen, oxygen, and argon molecules, and the temperature is relatively low. The enthalpy is expressed as

$$H\ (\text{cal/mole}) = a + bT + cT^2\ ,\ T\ (^\circ\text{K})$$

where the coefficients for the various species are

Gas	Temperature Range	a	b	c
A	250-400°K	0	4.9679750	0
O_2	250-400°K	2.8601800(1)	6.6591078	6.2596273(-4)
N_2	250-400°K	3.8580000	6.9106551	8.9250203(-5)

At the high temperature behind the shock, air consists of a mixture of molecules, atoms, and ions. In the present work as many as 13 species are assumed to be present. Because of the large range in temperature behind the shock, higher-order polynomials are used, and in some cases the coefficients are evaluated for discrete temperature ranges.

The equations are

Enthalpy, $$\frac{H - H^o}{R\,T} = a + bT + cT^2 + dT^3 + eT^4$$

Free Energy, $$\frac{F - H^o}{R\,T} = a\,(1 - \ln T) - bT - \frac{c}{2}T^2 - \frac{d}{3}T^3 - \frac{e}{4}T^4 - k$$

where R is the univeral gas constant, H^o is the heat of formation of the various species, and k is a constant for each of the species.

The coefficients and constants in these polynomials have been evaluated by Fickett and Cowan for the molecules N_2, NO, and O_2 for two temperature ranges, 500 to 3000°K and 3000 to 12,000°K. Duff has obtained polynomial fits for the atoms O and N for the same temperature ranges. Since the ionized species occur only at the higher temperatures, polynomicals have been fitted at CAL for the range 3000 to 10,000°K. The coefficients, the heat of formation, H^o, and the constant k are given on the following page.

Gas	Temperature Range	a	b	c	d	e	k	H^o
N_2	500- 3,000°K	3.3443500	2.9426000(-4)	1.9530000(-9)	-6.5745000(-12)	0	3.7586300	0
N_2	3,000-12,000°K	3.5144300	2.5831400(-4)	-2.8410700(-8)	1.2415400(-12)	0	2.7411300	0
NO	500- 3,000°K	3.5017400	2.9938000(-4)	-9.5880000(-9)	-4.9036000(-12)	0	5.1134600	2.1477000(4)
NO	3,000-12,000°K	3.7449300	1.9497500(-4)	-1.8828400(-8)	7.7028000(-13)	0	3.7132900	2.1477000(4)
O_2	500- 3,000°K	3.2530400	6.5235000(-4)	-1.4952400(-7)	1.5389700(-11)	0	5.7124300	0
O_2	3,000-12,000°K	3.5506400	3.2031200(-4)	-2.8757500(-8)	1.0052800(-12)	0	4.2094500	0
O	500- 3,000°K	2.7640276	-2.5142685(-4)	1.0018675(-7)	-1.3867004(-11)	0	3.7330900	5.8980000(4)
O	3,000-12,000°K	2.5940875	-3.8431865(-5)	7.5142841(-9)	-3.2094308(-13)	0	4.5799300	5.8980000(4)
N	500- 3,000°K	2.4990624	2.8744113(-6)	-2.4481595(-9)	6.1515069(-13)	0	4.1850400	1.1259064(5)
N	3,000-12,000°K	2.7037524	-1.4179802(-4)	2.8470463(-8)	-1.1789366(-12)	0	3.0613600	1.1259064(5)
A	Up to 12,000°K	2.5000000	0	0	0	0	0	0
e^-	- - -	2.5000000	0	0	0	0	-1.1735000(1)	0
N_2^+	3,000-10,000°K	2.9711400	5.1822203(-4)	-3.7705301(-8)	-1.4528000(-13)	7.7395703(-17)	6.6583800	3.5922900(5)
O_2^+	3,000-10,000°K	3.3283300	4.7378801(-4)	-9.3131001(-8)	8.8298702(-12)	-2.7676800(-16)	5.5694660	2.7790900(5)
N^+	3,000-10,000°K	2.5891600	0.5768801(-5)	1.6864500(-3)	-1.3758700(-12)	3.9675202(-17)	4.5120699	4.4783700(5)
NO^+	3,000-10,000°K	3.1350000	6.4678501(-4)	-1.8325100(-7)	2.6243300(-11)	-1.1649800(-15)	5.5529400	2.3533000(5)
O^+	3,000-10,000°K	2.3755800	7.7463703(-5)	-2.3069400(-8)	3.0130801(-12)	-1.1480600(-16)	5.1464690	3.7296900(5)
O^-	3,000-10,000°K	2.6245500	-1.0265300(-4)	2.6213200(-8)	-2.0612900(-12)	5.4884502(-17)	4.1422300	2.6701200(4)

TABLE I ATMOSPHERIC PROPERITIES AS A FUNCTION OF ALTITUDE

Alt. (ft)	T (°R)	p (psfa)	$\rho\left(\frac{slugs}{ft^3}\right)$	$a\left(\frac{ft}{sec}\right)$	$\mu\left(\frac{slugs}{ft\text{-}sec}\right)$	λ (ft)	$H\left(\frac{ft\text{-}lb}{slug}\right)$	$\frac{Re}{ML}\left(ft^{-1}\right)$
0	518.69	2.1162(+3)	2.3769(-3)	1116.4	3.7373(-7)	2.1758(-7)	3.1047(+6)	7.1002(+6)
10,000	483.04	1.4556(+3)	1.7556(-3)	1077.4	3.5344(-7)	2.9458(-7)	2.8907(+6)	5.3518(+6)
20,000	447.43	9.7327(+2)	1.2673(-3)	1036.9	3.3245(-7)	4.0809(-7)	2.6770(+6)	3.9527(+6)
30,000	411.86	6.2966(+2)	8.9068(-4)	994.85	3.1070(-7)	5.8064(-7)	2.4639(+6)	2.8519(+6)
40,000	389.99	3.9312(+2)	5.8727(-4)	968.08	2.9692(-7)	8.8062(-7)	2.3330(+6)	1.9147(+6)
50,000	389.99	2.4361(+2)	3.6391(-4)	968.08	2.9692(-7)	1.4211(-6)	2.3330(+6)	1.1865(+6)
60,000	389.99	1.5103(+2)	2.2561(-4)	968.08	2.9692(-7)	2.2623(-6)	2.3330(+6)	7.3558(+5)
70,000	389.99	9.3672(+1)	1.3993(-4)	968.08	2.9692(-7)	3.6958(-6)	2.3330(+6)	4.5623(+5)
80,000	389.99	5.8125(+1)	8.6831(-5)	968.08	2.9692(-7)	5.9560(-6)	2.3330(+6)	2.8310(+5)
90,000	402.48	3.6292(+1)	5.2531(-5)	983.46	3.0484(-7)	9.8449(-6)	2.4078(+6)	1.6947(+5)
100,000	418.79	2.3085(+1)	3.2114(-5)	1003.2	3.1501(-7)	1.6104(-5)	2.5054(+6)	1.0227(+5)
110,000	435.09	1.4947(+1)	2.0014(-5)	1022.5	3.2499(-7)	2.5840(-5)	2.6031(+6)	6.2969(+4)
120,000	451.37	9.8372	1.2697(-5)	1041.5	3.3480(-7)	4.0731(-5)	2.7007(+6)	3.9498(+4)
130,000	467.63	6.5735	8.1894(-6)	1060.1	3.4444(-7)	6.3150(-5)	2.7982(+6)	2.5205(+4)
140,000	483.88	4.4552	5.3640(-6)	1078.3	3.5392(-7)	9.6413(-5)	2.8957(+6)	1.6343(+4)
150,000	500.11	3.0597	3.5642(-6)	1096.3	3.6324(-7)	1.4510(-4)	2.9931(+6)	1.0757(+4)
160,000	508.79	2.1247	2.4329(-6)	1105.7	3.6816(-7)	2.1257(-4)	3.0452(+6)	7.3068(+3)
170,000	508.79	1.4784	1.6929(-6)	1105.7	3.6816(-7)	3.0549(-4)	3.0452(+6)	5.0843(+3)
180,000	497.49	1.0272	1.2028(-6)	1093.4	3.6175(-7)	4.2995(-4)	2.9773(+6)	3.6355(+3)
190,000	473.24	7.0278(-1)	8.6517(-7)	1066.4	3.4773(-7)	5.9776(-4)	2.8319(+6)	2.6533(+3)
200,000	449.00	4.7151(-1)	6.1180(-7)	1038.7	3.3339(-7)	8.4532(-4)	2.6864(+6)	1.9061(+3)
210,000	424.79	3.0955(-1)	4.2454(-7)	1010.3	3.1870(-7)	1.2182(-3)	2.5413(+6)	1.3458(+3)
220,000	400.60	1.9835(-1)	2.8845(-7)	981.16	3.0365(-7)	1.7929(-3)	2.3966(+6)	9.3205(+2)
230,000	376.44	1.2368(-1)	1.9141(-7)	951.11	2.8822(-7)	2.7019(-3)	2.2519(+6)	6.3164(+2)
240,000	352.30	7.4774(-2)	1.2365(-7)	920.11	2.7237(-7)	4.1824(-3)	2.1076(+6)	4.1771(+2)
250,000	328.2	4.364(-2)	7.748(-8)	888.1	2.561(-7)	6.675 (-3)	1.9636(+6)	2.687 (+2)
260,000	304.1	2.446(-2)	4.686(-8)	854.8	2.394(-7)	1.104(-2)	1.8198(+6)	1.673 (+2)
270,000	298.2	1.327(-2)	2.593(-8)	846.5	2.352(-7)	1.995(-2)	1.7847(+6)	8.778(+1)
280,000	298.2	7.194(-3)	1.406(-8)	846.5	2.352(-7)	3.679(-2)	1.7847(+6)	5.060(+1)
290,000	298.2	3.902(-3)	7.624(-9)	846.5	2.352(-7)	6.784(-2)	1.7847(+6)	2.744(+1)
300,000	299.2	2.118(-3)	4.129(-9)	848.3	2.359(-7)	1.254(-1)	1.7906(+6)	1.483(+1)

NUMBERS IN PARENTHESIS INDICATE POWER OF 10 THE NUMBER IS TO BE MULTIPLIED BY; e.g. $2.118(-3) \equiv 2.118 \times 10^{-3}$

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 0 feet
Temperature: 518.69°R
Pressure: 2116.2 psfa
Enthalpy: 3.1047×10^6 ft-lb/slug
Density: 2.3769×10^{-3} slugs/ft^3
Sonic Speed: 1116.4 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	1.791	2.325	3.559	1.531	1.000	1.525	1.644	4.527	1.650	1.416
3000	2.687	3.615	8.309	2.299	1.000	2.338	2.449	9.707	2.408	1.382
4000	3.583	4.537	15.00	3.307	1.000	3.451	3.577	16.98	3.427	1.366
5000	4.479	5.217	23.69	4.540	1.000	4.877	5.026	26.38	4.678	1.351
6000	5.374	5.768	34.41	5.966	1.000	6.621	6.798	37.91	6.122	1.336
7000	6.270	6.261	47.22	7.542	1.000	8.687	8.891	51.62	7.717	1.320
8000	7.166	6.731	62.18	9.230	1.001	11.08	11.31	67.52	9.420	1.303
9000	8.062	7.204	79.31	10.96	1.004	13.78	14.04	85.63	11.16	1.287
10,000	8.957	7.697	98.68	12.64	1.014	16.83	17.10	106.0	12.86	1.270
11,000	9.853	8.184	120.2	14.26	1.030	20.18	20.49	128.5	14.47	1.255
12,000	10.75	8.617	143.9	15.86	1.053	23.86	24.19	153.3	16.07	1.243
13,000	11.64	8.960	169.6	17.52	1.080	27.85	28.22	180.2	17.73	1.235
14,000	12.54	9.198	197.1	19.31	1.110	32.19	32.56	209.1	19.53	1.230
15,000	13.44	9.360	226.6	21.27	1.138	36.80	37.24	240.1	21.51	1.227
16,000	14.33	9.510	258.2	23.28	1.166	41.76	42.23	273.3	23.53	1.224
17,000	15.23	9.702	292.0	25.20	1.194	47.02	47.54	308.7	25.47	1.220
18,000	16.12	9.941	328.2	26.96	1.224	52.62	53.18	346.5	27.23	1.215
19,000	17.02	10.21	366.6	28.67	1.257	58.56	59.14	386.4	28.84	1.210
20,000	17.91	10.49	407.3	30.05	1.292	64.79	65.42	428.7	30.32	1.204
21,000	18.81	10.76	450.1	31.45	1.330	71.38	72.02	473.1	31.72	1.199
22,000	19.71	11.03	495.1	32.78	1.370	78.28	78.95	519.7	33.06	1.194
23,000	20.60	11.27	542.2	34.07	1.412	85.50	86.19	568.6	34.34	1.190
24,000	21.50	11.49	591.4	35.35	1.456	93.04	93.76	619.5	35.62	1.186
25,000	22.39	11.69	642.7	36.62	1.501	100.9	101.7	672.7	36.89	1.183
26,000	23.29	11.86	695.9	37.91	1.548	109.0	109.9	727.9	38.18	1.180

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 10,000 feet
Pressure: 1455.6 psfa
Density: 1.7556×10^{-3} slugs/ft^3
Temperature: 483.04 °R
Enthalpy: 2.8907×10^6 ft-lb/slug
Sonic Speed: 1077.4 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	1.856	2.421	3.830	1.582	1.000	1.574	1.692	4.826	1.701	1.418
3000	2.784	3.711	8.926	2.406	1.000	2.443	2.557	10.39	2.516	1.385
4000	3.713	4.617	16.11	3.489	1.000	3.637	3.768	18.20	3.614	1.368
5000	4.641	5.281	25.43	4.816	1.000	5.168	5.324	28.29	4.960	1.353
6000	5.569	5.818	36.94	6.349	1.000	7.041	7.227	40.67	6.515	1.337
7000	6.497	6.300	50.69	8.046	1.000	9.258	9.476	55.38	8.231	1.321
8000	7.425	6.774	66.76	9.847	1.001	11.82	12.07	72.46	10.05	1.304
9000	8.353	7.243	85.16	11.70	1.005	14.74	15.01	91.91	11.91	1.287
10,000	9.282	7.748	106.0	13.48	1.015	18.00	18.30	113.8	13.69	1.270
11,000	10.21	8.249	129.2	15.16	1.033	21.62	21.93	138.0	15.38	1.254
12,000	11.14	8.695	154.6	16.83	1.057	25.58	25.91	164.6	17.05	1.242
13,000	12.07	9.045	182.2	18.57	1.085	29.86	30.23	193.5	18.79	1.233
14,000	12.99	9.283	211.8	20.46	1.115	34.50	34.90	224.6	20.69	1.228
15,000	13.92	9.440	243.5	22.54	1.144	39.46	39.92	257.9	22.79	1.225
16,000	14.85	9.590	277.4	24.68	1.172	44.78	45.28	293.5	24.95	1.223
17,000	15.78	9.790	313.8	26.70	1.200	50.44	50.99	331.6	26.98	1.219
18,000	16.71	10.04	352.7	28.54	1.231	56.48	57.04	372.1	28.82	1.213
19,000	17.64	10.32	394.0	30.21	1.264	62.83	63.44	415.1	30.49	1.207
20,000	18.56	10.61	437.8	31.75	1.300	69.56	70.19	460.5	32.03	1.202
21,000	19.49	10.89	483.8	33.19	1.338	76.61	77.28	508.2	33.47	1.196
22,000	20.42	11.17	532.2	34.58	1.379	84.04	84.72	558.4	34.86	1.191
23,000	21.35	11.42	582.9	35.92	1.421	91.75	92.50	610.8	36.20	1.187
24,000	22.28	11.65	635.8	37.24	1.466	99.88	100.6	665,6	37.52	1.183
25,000	23.20	11.85	690.9	38.56	1.512	108.3	109.1	722.7	38.83	1.180
26,000	24.13	12.02	748.1	39.89	1.560	117.1	117.9	782.1	40.17	1.178

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 20,000 feet
Pressure: 973.27 psfa
Density: 1.2673×10^{-3} slugs/ft^3
Temperature: 447.43 °R
Enthalpy: 2.6770×10^6 ft-lb/slug
Sonic Speed: 1036.9 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	1.929	2.526	4.145	1.641	1.000	1.630	1.747	5.176	1.759	1.421
3000	2.893	3.813	9.642	2.528	1.000	2.565	2.681	11.18	2.642	1.387
4000	3.858	4.700	17.39	3.701	1.000	3.852	3.988	19.61	3.831	1.370
5000	4.822	5.345	27.45	5.135	1.000	5.504	5.669	30.50	5.288	1.354
6000	5.786	5.868	39.87	6.794	1.000	7.526	7.724	43.86	6.970	1.339
7000	6.751	6.340	54.71	8.629	1.000	9.920	10.15	59.75	8.827	1.322
8000	7.715	6.801	72.05	10.58	1.001	12.69	12.95	78.17	10.80	1.305
9000	8.680	7.284	91.95	12.55	1.005	15.83	16.13	99.19	12.78	1.287
10,000	9.644	7.803	114.5	14.43	1.017	19.37	19.68	122.8	14.46	1.269
11,000	10.61	8.321	139.6	16.20	1.035	23.26	23.60	149.0	16.43	1.253
12,000	11.57	8.780	167.1	17.94	1.061	27.54	27.90	177.7	18.17	1.240
13,000	12.54	9.137	196.9	19.77	1.090	32.18	32.57	208.9	20.00	1.231
14,000	13.50	9.375	228.9	21.78	1.121	37.18	37.61	242.5	22.02	1.227
15,000	14.47	9.527	263.1	24.00	1.150	42.53	43.02	278.5	24.26	1.224
16,000	15.43	9.677	299.8	26.29	1.178	48.27	48.81	317.0	26.57	1.221
17,000	16.40	9.886	339.1	28.42	1.207	54.41	54.98	358.1	28.71	1.217
18,000	17.36	10.15	381.1	30.35	1.238	60.92	61.52	401.9	30.64	1.211
19,000	18.32	10.44	425.8	32.09	1.271	67.77	68.43	448.3	32.38	1.205
20,000	19.29	10.74	473.1	33.69	1.308	75.07	75.71	497.4	33.98	1.199
21,000	20.25	11.04	523.0	35.19	1.346	82.63	83.37	549.0	35.48	1.194
22,000	21.22	11.32	575.3	36.62	1.388	90.68	91.40	603.1	36.91	1.189
23,000	22.18	11.58	630.0	38.02	1.431	99.03	99.80	659.8	38.30	1.185
24,000	23.15	11.82	687.2	39.39	1.476	107.7	108.6	719.0	39.67	1.181
25,000	24.11	12.03	746.8	40.77	1.523	116.9	117.7	780.6	41.05	1.178
26,000	25.07	12.21	808.7	42.16	1.572	126.4	127.2	844.8	42.44	1.175

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 30,000 feet
Pressure: 629.66 psfa
Density: 8.9068×10^{-4} slugs/ft^3
Temperature: 411.86°R
Enthalpy: 2.4639×10^6 ft-lb/slug
Sonic Speed: 994.85 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	2.010	2.641	4.514	1.709	1.000	1.696	1.812	5.586	1.827	1.422
3000	3.016	3.921	10.48	2.672	1.000	2.707	2.826	12.10	2.790	1.389
4000	4.021	4.786	18.90	3.948	1.000	4.104	4.247	21.26	4.084	1.372
5000	5.026	5.412	29.82	5.509	1.000	5.898	6.073	33.08	5.671	1.356
6000	6.031	5.920	43.30	7.315	1.000	8.095	8.306	47.60	7.503	1.340
7000	7.036	6.381	59.42	9.312	1.000	10.70	10.94	64.85	9.524	1.324
8000	8.041	6.838	78.26	11.43	1.001	13.70	13.99	84.87	11.66	1.306
9000	9.047	7.328	99.47	13.49	1.006	17.05	17.37	107.2	13.73	1.288
10,000	10.05	7.864	123.9	15.47	1.018	20.86	21.20	132.8	15.71	1.269
11,000	11.06	8.400	151.1	17.32	1.039	25.10	25.45	161.2	17.56	1.252
12,000	12.06	8.874	180.9	19.14	1.065	29.71	30.09	192.3	19.38	1.238
13,000	13.07	9.240	213.2	21.05	1.096	34.74	35.15	226.0	21.29	1.230
14,000	14.07	9.476	247.8	23.20	1.127	40.13	40.60	262.4	23.46	1.225
15,000	15.08	9.621	286.1	25.70	1.157	46.15	46.66	302.6	25.97	1.222
16,000	16.08	9.772	325.9	28.15	1.185	52.40	52.95	344.4	28.44	1.219
17,000	17.09	9.991	368.7	30.41	1.213	59.02	59.65	389.2	30.71	1.215
18,000	18.09	10.27	414.5	32.43	1.245	66.12	66.75	436.8	32.73	1.209
19,000	19.10	10.58	463.2	34.25	1.279	73.69	74.26	487.3	34.55	1.203
20,000	20.10	10.89	514.6	35.92	1.316	81.49	82.17	540.6	36.22	1.197
21,000	21.11	11.20	568.8	37.49	1.355	89.73	90.49	596.7	37.79	1.191
22,000	22.11	11.49	625.8	38.98	1.397	98.43	99.22	655.6	39.28	1.186
23,000	23.12	11.76	685.4	40.44	1.441	107.5	108.4	717.2	40.73	1.182
24,000	24.12	12.01	747.6	41.87	1.487	117.0	117.9	781.5	42.16	1.178
25,000	25.13	12.22	812.4	43.31	1.535	127.0	127.8	848.5	43.60	1.175
26,000	26.13	12.41	879.8	44.77	1.584	137.3	138.2	918.3	45.06	1.172

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 40,000 feet
Pressure: 393.12 psfa
Density: 5.8727×10^{-4} slugs/ft^3
Temperature: 389.99°R
Enthalpy: 2.3330×10^6 ft-lb/slug
Sonic Speed: 968.08 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	2.066	2.717	4.775	1.757	1.000	1.741	1.857	5.874	1.874	1.423
3000	3.099	3.991	11.07	2.774	1.000	2.807	2.929	12.76	2.894	1.391
4000	4.132	4.841	19.96	4.122	1.000	4.282	4.429	22.42	4.263	1.373
5000	5.165	5.454	31.49	5.773	1.000	6.176	6.358	34.91	5.941	1.357
6000	6.198	5.952	45.72	7.682	1.000	8.495	8.715	50.24	7.879	1.341
7000	7.231	6.407	62.75	9.793	1.000	11.24	11.50	68.46	10.02	1.325
8000	8.264	6.865	82.64	12.02	1.001	14.41	14.72	89.61	12.27	1.307
9000	9.297	7.370	105.5	14.22	1.007	18.04	18.36	113.7	14.47	1.287
10,000	10.33	7.929	131.5	16.25	1.021	22.09	22.43	140.9	16.60	1.267
11,000	11.36	8.489	160.4	18.13	1.042	26.55	26.93	171.0	18.38	1.250
12,000	12.40	8.981	192.1	19.98	1.071	31.49	31.86	204.1	20.22	1.236
13,000	13.43	9.356	226.4	21.95	1.102	36.77	37.22	239.9	22.20	1.227
14,000	14.46	9.588	263.1	24.18	1.135	42.54	43.01	278.4	24.44	1.222
15,000	15.49	9.724	302.4	26.71	1.165	48.72	49.22	319.7	26.99	1.220
16,000	16.53	9.879	344.6	29.26	1.192	55.27	55.87	363.9	29.56	1.217
17,000	17.56	10.11	389.9	31.57	1.221	62.31	62.94	411.2	31.88	1.212
18,000	18.59	10.41	438.3	33.81	1.253	69.79	70.44	461.6	33.92	1.206
19,000	19.63	10.73	489.8	35.44	1.287	77.64	78.37	514.9	35.74	1.200
20,000	20.66	11.07	544.3	37.12	1.325	85.99	86.73	571.3	37.42	1.194
21,000	21.69	11.39	601.7	38.70	1.365	94.73	95.51	630.6	39.00	1.188
22,000	22.73	11.69	661.9	40.20	1.408	103.9	104.7	692.8	40.49	1.183
23,000	23.76	11.98	724.9	41.66	1.453	113.6	114.4	757.9	41.95	1.178
24,000	24.79	12.23	790.8	43.11	1.500	123.6	124.4	825.9	43.40	1.175
25,000	25.82	12.46	859.3	44.56	1.548	134.0	134.9	896.8	44.85	1.171
26,000	26.86	12.65	930.6	46.04	1.598	144.9	145.9	970.5	46.33	1.169

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 50,000 feet
Pressure: 243.61 psfa
Density: 3.6391×10^{-4} slugs/ft^3
Temperature: 389.99°R
Enthalpy: 2.3330×10^6 ft-lb/slug
Sonic Speed: 968.08 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	2.066	2.717	4.775	1.757	1.000	1.741	1.857	5.874	1.874	1.423
3000	3.099	3.991	11.07	2.774	1.000	2.807	2.929	12.76	2.894	1.391
4000	4.132	4.841	19.96	4.122	1.000	4.282	4.429	22.42	4.263	1.373
5000	5.165	5.454	31.49	5.773	1.000	6.176	6.358	34.91	5.941	1.357
6000	6.198	5.952	45.72	7.682	1.000	8.495	8.715	50.24	7.879	1.341
7000	7.231	6.408	62.75	9.791	1.000	11.24	11.50	68.46	10.01	1.325
8000	8.264	6.874	82.66	12.00	1.002	14.43	14.72	89.62	12.25	1.306
9000	9.297	7.405	105.6	14.14	1.008	18.03	18.36	113.8	14.39	1.286
10,000	10.33	7.997	131.6	16.08	1.024	22.09	22.43	141.0	16.32	1.264
11,000	11.36	8.585	160.6	17.86	1.047	26.56	26.93	171.2	18.10	1.246
12,000	12.40	9.099	192.4	19.63	1.077	31.47	31.86	204.2	19.86	1.232
13,000	13.43	9.482	226.7	21.53	1.111	36.82	37.22	240.0	21.76	1.223
14,000	14.46	9.707	263.5	23.74	1.144	42.56	43.01	278.6	23.99	1.219
15,000	15.49	9.833	302.8	26.25	1.173	48.70	49.22	319.9	26.52	1.217
16,000	16.53	9.996	345.0	28.75	1.200	55.28	55.87	364.1	29.03	1.214
17,000	17.56	10.25	390.4	30.98	1.229	62.31	62.94	411.5	31.27	1.209
18,000	18.59	10.57	439.0	32.92	1.262	69.81	70.44	461.9	33.21	1.203
19,000	19.63	10.92	490.7	34.65	1.297	77.69	78.37	515.4	34.94	1.196
20,000	20.66	11.27	545.3	36.23	1.335	85.99	86.73	571.8	36.52	1.190
21,000	21.69	11.61	602.8	37.72	1.377	94.79	95.51	631.1	38.00	1.184
22,000	22.73	11.93	663.1	39.14	1.420	104.0	104.7	693.4	39.41	1.179
23,000	23.76	12.23	726.3	40.52	1.466	113.6	114.4	758.6	40.79	1.174
24,000	24.79	12.49	792.2	41.90	1.514	123.6	124.4	826.7	42.17	1.170
25,000	25.82	12.73	860.9	43.28	1.563	134.1	134.9	897.6	43.55	1.167
26,000	26.86	12.93	932.3	44.69	1.614	145.0	145.9	971.4	44.95	1.165

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 60,000 feet
Pressure: 151.03 psfa
Density: 2.2561×10^{-4} slugs/ft^3
Temperature: 389.99 °R
Enthalpy: 2.3330×10^6 ft-lb/slug
Sonic Speed: 968.08 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	2.066	2.717	4.775	1.757	1.000	1.741	1.857	5.874	1.874	1.423
3000	3.099	3.991	11.07	2.774	1.000	2.807	2.929	12.76	2.894	1.391
4000	4.132	4.841	19.96	4.122	1.000	4.282	4.429	22.42	4.263	1.373
5000	5.165	5.464	31.49	5.773	1.000	6.176	6.358	34.91	5.941	1.357
6000	6.198	5.952	45.72	7.682	1.000	8.496	8.715	50.24	7.879	1.341
7000	7.231	6.409	62.75	9.789	1.000	11.24	11.50	68.46	10.01	1.324
8000	8.264	6.886	82.69	11.98	1.002	14.42	14.72	89.63	12.22	1.306
9000	9.297	7.445	105.7	14.06	1.010	18.04	18.36	113.8	14.30	1.284
10,000	10.33	8.070	131.8	15.90	1.027	22.09	22.43	141.1	16.14	1.261
11,000	11.36	8.688	160.9	17.59	1.053	26.59	26.93	171.3	17.82	1.243
12,000	12.40	9.222	192.7	19.27	1.084	31.49	31.86	204.4	19.49	1.229
13,000	13.43	9.613	227.1	21.12	1.119	36.83	37.22	240.2	21.34	1.220
14,000	14.46	9.827	263.9	23.31	1.152	42.55	43.01	278.8	23.55	1.216
15,000	15.49	9.941	303.2	25.83	1.181	48.72	49.22	320.1	26.09	1.214
16,000	16.53	10.12	345.5	28.27	1.208	55.31	55.87	364.4	28.54	1.211
17,000	17.56	10.40	391.0	30.40	1.237	62.47	62.94	411.8	30.68	1.206
18,000	18.59	10.74	439.7	32.24	1.270	69.81	70.44	462.3	32.52	1.199
19,000	19.63	11.11	491.5	33.87	1.306	77.72	78.37	515.8	34.14	1.192
20,000	20.66	11.48	546.2	35.37	1.345	86.04	86.73	572.2	35.64	1.186
21,000	21.69	11.84	603.9	36.77	1.387	94.80	95.51	631.7	37.03	1.180
22,000	22.73	12.18	664.3	38.12	1.432	104.0	104.7	694.0	38.38	1.175
23,000	23.76	12.48	727.6	39.43	1.478	113.6	114.4	759.3	39.68	1.170
24,000	24.79	12.76	793.7	40.73	1.527	123.6	124.4	827.4	40.98	1.167
25,000	25.82	13.01	862.5	42.05	1.577	134.1	134.9	898.4	42.30	1.163
26,000	26.86	13.21	934.0	43.40	1.629	145.0	145.9	972.2	43.65	1.161

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 70,000 feet
Pressure: 93.672 psfa
Density: 1.3993×10^{-4} slugs/ft^3
Temperature: 389.99 °R
Enthalpy: 2.3330×10^6 ft-lb/slug
Sonic Speed: 968.08 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	2.066	2.717	4.775	1.757	1.000	1.741	1.857	5.874	1.874	1.428
3000	3.099	3.991	11.07	2.774	1.000	2.807	2.929	12.76	2.894	1.391
4000	4.132	4.841	19.96	4.122	1.000	4.282	4.429	22.42	4.263	1.373
5000	5.165	5.454	31.49	5.773	1.000	6.176	6.358	34.91	5.941	1.357
6000	6.198	5.952	45.72	7.682	1.000	8.495	8.715	50.24	7.879	1.341
7000	7.231	6.411	62.75	9.786	1.000	11.24	11.50	68.46	10.01	1.324
8000	8.264	6.901	82.72	11.96	1.003	14.43	14.72	89.64	12.20	1.305
9000	9.297	7.490	105.8	13.96	1.012	18.04	18.36	113.9	14.20	1.281
10,000	10.33	8.151	132.0	15.71	1.031	22.10	22.43	141.2	15.95	1.258
11,000	11.36	8.798	161.1	17.31	1.058	26.59	26.93	171.4	17.54	1.239
12,000	12.40	9.352	193.0	18.92	1.091	31.50	31.86	204.5	19.15	1.225
13,000	13.43	9.747	227.5	20.72	1.126	36.81	37.22	240.4	20.96	1.216
14,000	14.46	9.946	264.2	22.90	1.160	42.57	43.01	279.0	23.13	1.213
15,000	15.49	10.05	303.5	25.43	1.188	48.73	49.22	320.3	25.68	1.212
16,000	16.53	10.24	345.9	27.81	1.215	55.32	55.87	364.6	28.07	1.208
17,000	17.56	10.55	391.6	29.84	1.245	62.36	62.94	412.1	30.11	1.202
18,000	18.59	10.92	440.5	31.58	1.278	69.83	70.44	463.5	31.84	1.195
19,000	19.63	11.31	492.4	33.12	1.315	77.74	78.37	516.2	33.38	1.188
20,000	20.66	11.70	547.2	34.53	1.355	86.07	86.73	572.8	34.78	1.182
21,000	21.69	12.07	605.0	35.86	1.397	94.83	95.51	632.2	36.11	1.176
22,000	22.73	12.43	665.5	37.13	1.442	104.0	104.7	694.6	37.37	1.171
23,000	23.76	12.75	728.9	38.38	1.490	113.6	114.4	759.9	38.62	1.166
24,000	24.79	13.04	795.1	39.62	1.539	123.7	124.4	828.1	39.85	1.163
25,000	25.82	13.29	864.0	40.87	1.590	134.1	135.0	899.2	41.10	1.159
26,000	26.86	13.51	935.7	42.17	1.643	145.0	145.9	973.0	42.40	1.157

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 80,000 feet
Pressure: 58.125 psfa
Density: 8.6831×10^{-5} slugs/ft^3
Temperature: 389.99°R
Enthalpy: 2.3330×10^6 ft-lb/slug
Sonic Speed: 968.08 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	2.066	2.717	4.775	1.757	1.000	1.741	1.857	5.874	1.874	1.423
3000	3.099	3.991	11.07	2.774	1.000	2.807	2.929	12.76	2.894	1.391
4000	4.132	4.841	19.96	4.122	1.000	4.282	4.429	22.42	4.263	1.373
5000	5.165	5.454	31.49	5.773	1.000	6.176	6.358	34.91	5.941	1.357
6000	6.198	5.952	45.72	7.682	1.000	8.495	8.715	50.24	7.879	1.341
7000	7.231	6.413	62.76	9.783	1.000	11.24	11.50	68.46	10.01	1.324
8000	8.264	6.918	82.75	11.92	1.003	14.42	14.72	89.66	12.16	1.304
9000	9.297	7.542	105.9	13.85	1.014	18.05	18.36	113.9	14.09	1.279
10,000	10.33	8.238	132.2	15.51	1.035	22.12	22.43	141.3	15.74	1.255
11,000	11.36	8.913	161.4	17.03	1.063	26.59	26.93	171.5	17.24	1.235
12,000	12.40	9.486	193.4	18.57	1.098	31.51	31.86	204.7	18.77	1.221
13,000	13.43	9.884	227.8	20.32	1.134	36.83	37.22	240.6	20.53	1.213
14,000	14.46	10.06	264.6	22.52	1.167	42.56	43.01	279.1	22.74	1.210
15,000	15.49	10.16	303.9	25.05	1.195	48.76	49.22	320.4	25.29	1.209
16,000	16.53	10.37	346.4	27.36	1.221	55.32	55.87	364.8	27.61	1.205
17,000	17.56	10.70	392.2	29.29	1.251	62.35	62.94	412.4	29.54	1.199
18,000	18.59	11.10	441.2	30.93	1.285	69.83	70.44	463.0	31.18	1.192
19,000	19.63	11.51	493.2	32.39	1.323	77.77	78.37	516.6	32.63	1.185
20,000	20.66	11.92	548.2	33.72	1.364	86.12	86.73	573.2	33.96	1.178
21,000	21.69	12.31	606.0	34.98	1.407	94.86	95.51	632.8	35.21	1.172
22,000	22.73	12.68	666.7	36.19	1.453	104.1	104.7	695.2	36.41	1.167
23,000	23.76	13.02	730.2	37.37	1.501	113.7	114.4	760.6	37.59	1.163
24,000	24.79	13.32	796.5	38.55	1.551	123.7	124.4	828.8	38.77	1.159
25,000	25.82	13.59	865.5	39.75	1.603	134.2	134.9	899.9	39.96	1.156
26,000	26.86	13.81	937.3	40.99	1.656	145.0	145.9	973.9	41.20	1.153

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 90,000 feet
Pressure: 36.292 psfa
Density: 5.2531×10^{-5} slugs/ft^3
Temperature: 402.48 °R
Enthalpy: 2.4078×10^6 ft-lb/slug
Sonic Speed: 983.46 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	2.034	2.673	4.622	1.729	1.000	1.714	1.831	5.705	1.846	1.419
3000	3.050	3.951	10.73	2.715	1.000	2.749	2.869	12.37	2.833	1.390
4000	4.067	4.810	19.34	4.020	1.000	4.178	4.323	21.74	4.158	1.372
5000	5.084	5.430	30.51	5.619	1.000	6.014	6.192	33.84	5.783	1.357
6000	6.101	5.934	44.31	7.467	1.000	8.261	8.476	48.70	7.659	1.341
7000	7.118	6.402	60.82	9.497	1.000	10.92	11.18	66.36	9.713	1.323
8000	8.135	6.931	80.24	11.53	1.004	14.01	14.29	86.92	11.76	1.302
9000	9.151	7.595	102.8	13.31	1.016	17.52	17.82	110.5	13.54	1.276
10,000	10.17	8.330	128.3	14.83	1.039	21.47	21.77	137.0	15.04	1.261
11,000	11.19	9.036	156.7	16.22	1.069	25.81	26.13	166.4	16.41	1.231
12,000	12.20	9.627	187.7	17.65	1.105	30.58	30.90	198.5	17.84	1.217
13,000	13.22	10.02	221.1	19.31	1.142	35.73	36.09	233.3	19.50	1.209
14,000	14.24	10.18	256.7	21.47	1.175	41.30	41.70	270.7	21.67	1.207
15,000	15.25	10.26	294.8	23.92	1.201	47.26	47.72	310,7	24.14	1.206
16,000	16.27	10.50	336.1	26.07	1.228	53.66	54.16	353.8	26.30	1.202
17,000	17.29	10.87	380.7	27.84	1.258	60.48	61.01	399.9	28.07	1.195
18,000	18.30	11.29	428.2	29.34	1.293	67.74	68.28	449.0	29.57	1.188
19,000	19.32	11.73	478.8	30.67	1.331	75.40	75.97	501.0	30.89	1.181
20,000	20.34	12.16	532.1	31.89	1.373	83.48	84.06	555.9	32.10	1.174
21,000	21.35	12.57	588.3	33.03	1.417	91.96	92.58	613.7	33.24	1.168
22,000	22.37	12.96	647.2	34.14	1.463	100.9	101.5	674.3	34.34	1.163
23,000	23.39	13.31	708.9	35.22	1.512	110.2	110.9	737.6	35.42	1.159
24,000	24.40	13.62	773.2	36.31	1.563	119.9	120.6	803.8	36.51	1.155
25,000	25.42	13.90	840.2	37.42	1.616	130.1	130.8	872.8	37.61	1.152
26,000	26.44	14.13	909.8	38.67	1.670	140.6	141.4	944.5	38.76	1.149

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 100,000 feet
Pressure: 23.085 psfa
Density: 3.2144×10^{-5} slugs/ft^3
Temperature: 418.79 °R
Enthalpy: 2.5054×10^6 ft-lb/slug
Sonic Speed: 1003.2 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	1.994	2.618	4.437	1.695	1.000	1.682	1.798	5.500	1.812	1.419
3000	2.990	3.900	10.31	2.643	1.000	2.677	2.796	11.91	2.733	1.388
4000	3.987	4.769	18.58	3.896	1.000	4.052	4.193	20.92	4.031	1.371
5000	4.984	5.399	29.32	5.431	1.000	5.816	5.989	32.54	5.591	1.356
6000	5.981	5.910	42.59	7.206	1.000	7.976	8.184	46.82	7.392	1.340
7000	6.978	6.388	58.47	9.149	1.000	10.53	10.78	63.80	9.357	1.323
8000	7.974	6.944	77.18	11.06	1.005	13.51	13.77	83.59	11.28	1.300
9000	8.971	7.652	98.91	12.69	1.019	16.88	17.17	106.3	12.90	1.272
10,000	9.968	8.425	123.5	14.06	1.043	20.66	20.96	131.8	14.25	1.247
11,000	10.96	9.159	150.9	15.32	1.075	24.84	25.15	160.1	15.50	1.226
12,000	11.96	9.768	180.7	16.64	1.112	29.42	29.74	191.0	16.81	1.213
13,000	12.96	10.16	212.9	18.22	1.150	34.40	34.73	224.4	18.39	1.205
14,000	13.96	10.28	247.0	20.33	1.182	39.75	40.12	260.3	20.52	1.204
15,000	14.95	10.37	283.7	22.68	1.207	46.47	45.90	298.8	22.89	1.204
16,000	15.95	10.64	323.5	24.66	1.234	51.62	52.09	340.3	24.88	1.199
17,000	16.95	11.03	366.4	26.26	1.265	58.18	58.68	384.6	26.47	1.192
18,000	17.94	11.48	412.3	27.62	1.300	65.14	65.66	431.9	27.83	1.184
19,000	18.94	11.94	460.8	28.82	1.339	72.51	73.04	482.0	29.02	1.177
20,000	19.94	12.40	512.3	29.93	1.381	80.28	80.83	534.8	30.12	1.170
21,000	20.93	12.83	566.4	30.97	1.426	88.44	89.01	590.3	31.16	1.164
22,000	21.93	13.23	623.1	31.97	1.473	97.01	97.59	648.6	32.15	1.159
23,000	22.93	13.60	682.5	32.96	1.523	106.0	106.6	709.5	33.14	1.155
24,000	23.92	13.92	744.4	33.96	1.574	115.3	116.0	773.1	34.13	1.151
25,000	24.92	14.21	808.9	34.97	1.628	125.1	125.7	839.5	35.14	1.148
26,000	25.92	14.44	875.9	36.04	1.683	135.2	135.9	908.4	36.21	1.146

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 110,000 feet
Pressure: 14.947 psfa
Density: 2.0014×10^{-5} slugs/ft^3
Temperature: 435.09 °R
Enthalpy: 2.6031×10^{6} ft-lb/slug
Sonic Speed: 1022.5 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	1.956	2.565	4.266	1.663	1.000	1.651	1.768	5.310	1.781	1.421
3000	2.934	3.850	9.917	2.576	1.000	2.612	2.729	11.48	2.691	1.388
4000	3.912	4.730	17.89	3.782	1.000	3.935	4.073	20.15	3.914	1.371
5000	4.890	5.368	28.23	5.258	1.000	5.634	5.802	31.34	5.414	1.355
6000	5.868	5.887	41.00	6.964	1.000	7.713	7.915	45.09	7.144	1.339
7000	6.846	6.375	56.29	8.825	1.001	10.18	10.41	61.44	9.026	1.322
8000	7.824	6.962	74.35	10.62	1.006	13.04	13.29	80.51	10.82	1.297
9000	8.802	7.713	95.35	12.10	1.022	16.29	16.56	102.4	12.30	1.268
10,000	9.780	8.522	119.1	13.34	1.048	19.94	20.21	127.0	13.52	1.242
11,000	10.76	9.283	145.5	14.50	1.081	23.97	24.24	154.2	14.66	1.222
12,000	11.74	9.907	174.3	15.72	1.119	28.38	28.66	184.0	15.88	1.208
13,000	12.71	10.29	205.2	17.24	1.157	33.15	33.46	216.2	17.40	1.202
14,000	13.69	10.38	238.0	19.32	1.187	38.27	38.65	250.7	19.50	1.201
15,000	14.67	10.47	273.4	21.55	1.212	43.81	44.22	287.8	21.74	1.201
16,000	15.65	10.77	311.8	23.37	1.239	49.73	50.17	327.7	23.57	1.196
17,000	16.63	11.20	353.2	24.83	1.271	56.05	56.51	370.5	25.03	1.188
18,000	17.60	11.67	397.5	26.06	1.307	62.76	63.24	416.1	26.25	1.180
19,000	18.58	12.16	444.4	27.16	1.346	69.85	70.34	464.3	27.34	1.173
20,000	19.56	12.63	494.0	28.16	1.389	77.33	77.83	515.2	28.33	1.166
21,000	20.54	13.08	546.1	29.11	1.434	85.18	85.71	568.7	29.28	1.160
22,000	21.52	13.50	600.8	30.03	1.482	93.43	93.97	624.8	30.20	1.155
23,000	22.49	13.88	658.0	30.94	1.532	102.0	102.6	683.5	31.10	1.151
24,000	23.47	14.22	717.7	31.85	1.585	111.1	111.6	744.8	32.01	1.147
25,000	24.45	14.51	779.9	32.79	1.639	120.4	121.1	808.7	32.94	1.144
26,000	25.43	14.76	844.4	33.78	1.694	130.2	130.8	875.1	33.93	1.142

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 120,000 feet
Pressure: 9.8372 psfa
Density: 1.2697×10^{-5} slugs/ft^3
Temperature: 451.37 °R
Enthalpy: 2.7007×10^6 ft-lb/slug
Sonic Speed: 1041.5 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	1.920	2.514	4.108	1.634	1.000	1.623	1.741	5.134	1.752	1.420
3000	2.880	3.802	9.557	2.514	1.000	2.550	2.666	11.09	2.628	1.387
4000	3.841	4.691	17.24	3.676	1.000	3.827	3.962	19.44	3.805	1.370
5000	4.801	5.338	27.21	5.097	1.000	5.465	5.629	30.23	5.249	1.354
6000	5.761	5.864	39.52	6.740	1.000	7.469	7.665	43.49	6.915	1.339
7000	6.721	6.363	54.28	8.524	1.001	9.847	10.07	59.25	8.718	1.320
8000	7.681	6.983	71.74	10.20	1.007	12.60	12.85	77.66	10.40	1.295
9000	8.641	7.776	92.06	11.55	1.025	15.74	16.00	98.78	11.74	1.264
10,000	9.602	8.619	115.0	12.69	1.052	19.26	19.51	122.5	12.86	1.238
11,000	10.56	9.406	140.5	13.75	1.086	23.13	23.40	148.8	13.90	1.218
12,000	11.52	10.04	168.3	14.89	1.125	27.38	27.66	177.5	15.03	1.204
13,000	12.48	10.41	198.1	16.36	1.163	31.98	32.29	208.6	16.51	1.198
14,000	13.44	10.46	229.7	18.41	1.193	36.96	37.29	241.8	18.58	1.199
15,000	14.40	10.57	263.8	20.52	1.216	42.27	42.66	277.6	20.70	1.198
16,000	15.36	10.90	301.0	22.20	1.244	47.98	48.40	316.1	22.38	1.193
17,000	16.32	11.36	341.0	23.52	1.276	54.08	54.51	357.4	23.70	1.185
18,000	17.28	11.86	383.8	24.65	1.313	60.54	60.99	401.4	24.82	1.177
19,000	18.24	12.37	429.1	25.65	1.353	67.38	67.84	447.9	25.82	1.169
20,000	19.20	12.86	476.9	26.57	1.396	74.57	75.06	497.0	26.73	1.163
21,000	20.16	13.32	527.2	27.44	1.442	82.17	82.65	548.6	27.59	1.157
22,000	21.12	13.76	580.0	28.29	1.490	90.12	90.61	602.7	28.44	1.152
23,000	22.08	14.15	635.3	29.12	1.541	98.42	98.94	659.4	29.27	1.148
24,000	23.04	14.51	692.9	29.96	1.594	107.1	107.6	718.5	30.10	1.144
25,000	24.00	14.81	752.9	30.83	1.649	116.2	116.7	780.1	30.97	1.141
26,000	24.96	15.06	815.2	31.75	1.705	125.6	126.2	844.2	31.89	1.139

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 130,000 feet
Pressure: 6.5735 psfa
Density: 8.1894×10^{-6} slugs/ft^3
Temperature: 467.63 °R
Enthalpy: 2.7982×10^6 ft-lb/slug
Sonic Speed: 1060.1 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	1.887	2.465	3.961	1.606	1.000	1.597	1.715	4.971	1.725	1.419
3000	2.830	3.755	9.223	2.456	1.000	2.949	2.608	10.72	2.569	1.386
4000	3.773	4.653	16.64	3.577	1.000	3.726	3.859	18.78	3.704	1.369
5000	4.717	5.308	26.27	4.948	1.000	5.307	5.467	29.20	5.096	1.353
6000	5.660	5.841	38.16	6.532	1.000	7.242	7.433	41.99	6.702	1.338
7000	6.603	6.353	52.41	8.242	1.001	9.536	9.756	57.22	8.430	1.319
8000	7.546	7.009	69.33	9.808	1.009	12.21	12.44	75.01	9.997	1.292
9000	8.490	7.843	89.01	11.05	1.027	15.23	15.47	95.44	11.22	1.260
10,000	9.433	8.718	111.2	12.08	1.056	18.63	18.87	118.4	12.23	1.234
11,000	10.38	9.528	135.9	13.06	1.092	22.39	22.62	143.8	13.20	1.214
12,000	11.32	10.18	162.7	14.14	1.131	26.48	26.73	171.5	14.27	1.201
13,000	12.26	10.53	191.5	15.56	1.169	30.92	31.20	201.5	15.70	1.195
14,000	13.21	10.54	221.9	17.59	1.197	35.69	36.02	233.5	17.74	1.197
15,000	14.15	10.67	254.9	19.58	1.220	40.83	41.20	268.1	19.75	1.196
16,000	15.09	11.03	290.9	21.12	1.248	46.35	46.74	305.4	21.29	1.190
17,000	16.04	11.52	329.6	22.33	1.281	52.24	52.64	345.3	22.50	1.182
18,000	16.98	12.04	371.0	23.36	1.318	58.48	58.90	387.7	23.52	1.174
19,000	17.92	12.57	414.8	24.28	1.359	65.07	65.51	432.7	24.43	1.166
20,000	18.87	13.08	461.0	25.13	1.403	72.03	72.47	480.1	25.28	1.159
21,000	19.81	13.57	509.7	25.93	1.449	79.35	79.80	529.9	26.07	1.154
22,000	20.75	14.01	560.7	26.71	1.498	87.02	87.48	582.2	26.85	1.149
23,000	21.70	14.42	614.1	27.48	1.549	95.03	95.53	636.9	27.61	1.144
24,000	22.64	14.79	669.8	28.26	1.603	103.4	103.9	694.0	28.39	1.141
25,000	23.58	15.10	727.8	29.07	1.658	112.1	112.7	753.5	29.20	1.138
26,000	24.53	15.36	788.0	29.93	1.715	121.2	121.8	815.4	30.05	1.136

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 140,000 feet
Pressure: 4.4552 psfa
Density: 5.3640×10^{-6} slugs/ft^3
Temperature: 483.88°R
Enthalpy: 2.8957×10^6 ft-lb/slug
Sonic Speed: 1078.3 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	1.855	2.419	3.824	1.581	1.000	1.572	1.691	4.819	1.699	1.419
3000	2.782	3.709	8.911	2.403	1.000	2.441	2.554	10.37	2.514	1.385
4000	3.710	4.615	16.08	3.485	1.000	3.632	3.763	18.17	3.609	1.368
5000	4.637	5.279	25.39	4.809	1.000	5.160	5.317	28.24	4.953	1.353
6000	5.564	5.818	36.88	6.338	1.000	7.030	7.216	40.60	6.503	1.337
7000	6.492	6.345	50.67	7.977	1.001	9.245	9.461	55.32	8.158	1.318
8000	7.419	7.037	67.08	9.437	1.010	11.83	12.05	72.55	9.615	1.289
9000	8.346	7.911	86.16	10.57	1.030	14.76	14.99	92.23	10.73	1.257
10,000	9.274	8.816	107.7	11.52	1.060	18.04	18.27	114.5	11.66	1.230
11,000	10.20	9.649	131.5	12.43	1.097	21.67	21.89	139.1	12.56	1.210
12,000	11.13	10.31	157.5	13.45	1.136	25.62	25.86	165.9	13.57	1.197
13,000	12.06	10.64	185.3	14.83	1.174	29.91	30.18	194.8	14.96	1.191
14,000	12.98	10.62	214.7	16.84	1.201	34.53	34.84	225.8	16.99	1.195
15,000	13.91	10.76	246.6	18.72	1.224	39.50	39.85	259.2	18.88	1.193
16,000	14.84	11.17	281.5	20.13	1.252	44.83	45.20	295.3	20.29	1.187
17,000	15.77	11.68	319.0	21.24	1.286	50.51	50.90	333.9	21.39	1.179
18,000	16.69	12.22	359.0	22.19	1.324	56.55	56.95	375.0	22.34	1.170
19,000	17.62	12.77	401.4	23.03	1.365	62.93	63.33	418.5	23.16	1.163
20,000	18.55	13.30	446.2	23.81	1.409	69.66	70.07	465.5	23.94	1.156
21,000	19.48	13.80	493.3	24.55	1.456	76.72	77.15	512.5	24.68	1.151
22,000	20.40	14.26	542.6	25.27	1.505	84.13	84.57	563.0	25.39	1.146
23,000	21.33	14.69	594.3	25.99	1.557	91.88	92.34	616.0	26.11	1.141
24,000	22.26	15.06	648.2	26.71	1.611	99.98	100.5	671.2	26.83	1.138
25,000	23.18	15.38	704.3	27.47	1.667	108.4	108.9	728.7	27.59	1.135
26,000	24.11	15.64	762.5	28.27	1.724	117.7	117.2	788.5	28.39	1.133

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 150,000 feet
Pressure: 3.0597 psfa
Density: 3.5642×10^{-6} slugs/ft^3
Temperature: 500.11°R
Enthalpy: 2.9931×10^6 ft-lb/slug
Sonic Speed: 1096.3 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	1.824	2.374	3.696	1.557	1.000	1.549	1.668	4.677	1.676	1.417
3000	2.736	3.664	8.620	2.352	1.000	2.391	2.503	10.05	2.462	1.383
4000	3.649	4.578	15.56	3.399	1.000	3.544	3.673	17.60	3.521	1.367
5000	4.561	5.250	24.57	4.679	1.000	5.023	5.176	27.34	4.820	1.352
6000	5.473	5.796	35.69	6.156	1.000	6.832	7.014	39.30	6.318	1.336
7000	6.385	6.338	49.05	7.727	1.002	8.983	9.185	53.56	7.903	1.316
8000	7.297	7.070	64.98	9.087	1.011	11.46	11.69	70.25	9.257	1.286
9000	8.209	7.981	83.50	10.13	1.033	14.32	14.53	89.41	10.28	1.253
10,000	9.122	8.915	104.4	11.00	1.064	17.49	17.70	110.9	11.13	1.226
11,000	10.03	9.768	127.5	11.85	1.101	21.00	21.21	134.7	11.97	1.206
12,000	10.95	10.43	152.6	12.81	1.142	24.83	25.06	160.6	12.92	1.194
13,000	11.86	10.74	179.5	14.18	1.179	28.98	29.23	188.6	14.30	1.190
14,000	12.77	10.68	207.8	16.15	1.204	33.44	33.74	218.5	16.29	1.193
15,000	13.68	10.86	238.8	17.92	1.227	38.25	38.59	250.9	18.07	1.191
16,000	14.59	11.30	272.7	19.21	1.256	43.41	43.76	285.9	19.36	1.184
17,000	15.51	11.83	309.0	20.24	1.290	48.92	49.28	323.3	20.38	1.176
18,000	16.42	12.40	347.8	21.11	1.329	54.75	55.12	363.0	21.25	1.167
19,000	17.33	12.97	388.9	21.89	1.370	60.92	61.31	405.2	22.02	1.160
20,000	18.24	13.51	432.3	22.61	1.415	67.42	67.82	449.5	22.73	1.153
21,000	19.16	14.03	477.9	23.30	1.462	74.27	74.67	496.2	23.42	1.148
22,000	20.07	14.51	525.7	23.97	1.512	81.44	81.85	545.2	24.08	1.143
23,000	20.98	14.94	575.7	24.63	1.564	88.94	89.37	596.4	24.74	1.139
24,000	21.89	15.33	627.9	25.31	1.619	96.78	97.22	649.8	25.42	1.135
25,000	22.80	15.66	682.3	26.01	1.675	104.9	105.4	705.5	26.12	1.132
26,000	23.72	15.93	738.7	26.77	1.733	113.4	113.9	763.4	26.88	1.130

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 160,000 feet
Temperature: 508.79°R
Pressure: 2.1247 psfa
Enthalpy: 3.0452×10^6 ft-lb/slug
Density: 2.4329×10^{-6} slugs/ft^3
Sonic Speed: 1105.7 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	1.809	2.351	3.631	1.544	1.000	1.538	1.657	4.605	1.664	1.417
3000	2.713	3.641	8.472	2.327	1.000	2.366	2.478	9.889	2.436	1.383
4000	3.618	4.559	15.30	3.355	1.000	3.500	3.627	17.30	3.476	1.366
5000	4.522	5.235	24.15	4.613	1.000	4.954	5.105	26.88	4.752	1.351
6000	5.426	5.785	35.08	6.064	1.000	6.732	6.911	38.64	6.223	1.336
7000	6.331	6.341	48.24	7.593	1.002	8.844	9.045	52.66	7.765	1.315
8000	7.235	7.107	63.94	8.882	1.013	11.29	11.51	69.10	9.046	1.283
9000	8.140	8.052	82.19	9.854	1.036	14.09	14.30	87.96	9.998	1.249
10,000	9.044	9.012	102.8	10.68	1.068	17.22	17.42	109.1	10.81	1.222
11,000	9.948	9.884	125.5	11.48	1.106	20.66	20.87	132.5	11.59	1.203
12,000	10.85	10.55	150.2	12.41	1.146	24.42	24.64	158.0	12.52	1.191
13,000	11.76	10.83	176.6	13.78	1.183	28.50	28.75	185.5	13.89	1.188
14,000	12.66	10.75	204.4	15.76	1.207	32.89	33.18	214.9	15.89	1.191
15,000	13.57	10.96	235.0	17.43	1.230	37.63	37.94	246.8	17.57	1.189
16,000	14.47	11.42	268.3	18.65	1.260	42.69	43.03	281.2	18.80	1.181
17,000	15.37	11.98	304.2	19.61	1.294	48.10	48.45	318.0	19.75	1.173
18,000	16.28	12.57	342.3	20.43	1.333	53.84	54.20	357.1	20.56	1.165
19,000	17.18	13.15	382.8	21.17	1.375	59.91	60.27	398.5	21.29	1.157
20,000	18.09	13.72	425.4	21.85	1.420	66.30	66.68	442.1	21.97	1.151
21,000	18.99	14.25	470.3	22.49	1.468	73.03	73.41	488.0	22.60	1.145
22,000	19.90	14.74	517.4	23.12	1.518	80.07	80.47	536.2	23.23	1.140
23,000	20.80	15.19	566.6	23.75	1.571	87.46	87.86	586.5	23.85	1.136
24,000	21.71	15.58	617.9	24.40	1.625	95.16	95.57	639.1	24.50	1.133
25,000	22.61	15.92	671.4	25.07	1.682	103.2	103.6	693.9	25.17	1.130
26,000	23.51	16.20	726.9	25.79	1.740	111.5	112.0	750.8	25.89	1.128

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 170,000 feet
Pressure: 1.4784 psfa
Density: 1.6929×10^{-6} slugs/ft^3
Temperature: 508.79°R
Enthalpy: 3.0452×10^6 ft-lb/slug
Sonic Speed: 1105.7 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	1.809	2.351	3.631	1.544	1.000	1.538	1.657	4.605	1.664	1.417
3000	2.713	3.641	8.472	2.327	1.000	2.366	2.478	9.886	2.436	1.383
4000	3.618	4.559	15.30	3.355	1.000	3.500	3.627	17.30	3.476	1.366
5000	4.522	5.235	24.15	4.613	1.000	4.954	5.105	26.88	4.752	1.351
6000	5.426	5.786	35.08	6.063	1.000	6.732	6.911	38.64	6.222	1.336
7000	6.331	6.353	48.25	7.579	1.002	8.841	9.045	52.67	7.750	1.314
8000	7.235	7.151	64.01	8.824	1.014	11.30	11.51	69.13	8.985	1.281
9000	8.140	8.127	82.30	9.755	1.038	14.10	14.30	88.00	9.894	1.246
10,000	9.044	9.110	102.9	10.55	1.071	17.22	17.42	109.2	10.67	1.219
11,000	9.948	10.00	125.6	11.33	1.109	20.66	20.87	132.6	11.44	1.200
12,000	10.85	10.68	150.4	12.24	1.151	24.42	24.64	158.1	12.34	1.188
13,000	11.76	10.92	176.7	13.64	1.187	28.51	28.75	185.6	13.75	1.186
14,000	12.66	10.82	204.6	15.64	1.209	32.90	33.18	215.0	15.77	1.190
15,000	13.57	11.06	235.2	17.26	1.233	37.63	37.94	246.9	17.40	1.187
16,000	14.47	11.55	268.6	18.42	1.263	42.70	43.03	281.3	18.56	1.179
17,000	15.37	12.13	304.5	19.34	1.298	48.10	48.45	318.1	19.47	1.171
18,000	16.28	12.74	342.7	20.13	1.337	53.85	54.20	357.3	20.25	1.162
19,000	17.18	13.34	383.2	20.84	1.379	59.92	60.27	398.7	20.96	1.155
20,000	18.09	13.91	425.9	21.49	1.424	66.32	66.68	442.4	21.60	1.148
21,000	18.99	14.46	470.8	22.11	1.472	73.04	73.41	488.3	22.21	1.143
22,000	19.90	14.96	517.9	22.72	1.523	80.09	80.47	536.4	22.82	1.138
23,000	20.80	15.42	567.2	23.33	1.576	87.47	87.86	586.8	23.43	1.134
24,000	21.71	15.83	618.6	23.95	1.631	95.17	95.57	639.5	24.05	1.130
25,000	22.61	16.18	672.1	24.61	1.688	103.2	103.6	694.2	24.70	1.128
26,000	23.51	16.45	727.7	25.32	1.747	111.5	112.0	751.2	25.41	1.126

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 180,000 feet
Pressure: 1.0272 psfa
Density: 1.2028×10^{-6} slugs/ft^3
Temperature: 497.48°R
Enthalpy: 2.9773×10^{6} ft-lb/slug
Sonic Speed: 1093.4 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	1.829	2.381	3.716	1.560	1.000	1.553	1.672	4.742	1.614	1.417
3000	2.744	3.671	8.665	2.360	1.000	2.399	2.511	10.00	2.470	1.384
4000	3.658	4.584	15.64	3.412	1.000	3.558	3.687	17.69	3.535	1.367
5000	4.573	5.255	24.69	4.699	1.000	5.045	5.198	27.48	4.841	1.352
6000	5.487	5.802	35.88	6.183	1.000	6.863	7.046	39.51	6.345	1.336
7000	6.402	6.376	49.36	7.722	1.003	9.028	9.229	53.86	7.895	1.314
8000	7.317	7.202	65.51	8.958	1.015	11.53	11.75	70.72	9.116	1.279
9000	8.231	8.204	84.26	9.874	1.040	14.39	14.60	90.04	10.02	1.244
10,000	9.146	9.209	105.3	10.66	1.073	17.59	17.79	111.7	10.78	1.217
11,000	10.06	10.12	128.6	11.43	1.112	21.12	21.32	135.6	11.54	1.197
12,000	10.98	10.80	153.9	12.36	1.154	24.97	25.18	161.8	12.46	1.186
13,000	11.89	11.01	180.8	13.81	1.190	29.13	29.38	189.8	13.92	1.184
14,000	12.80	10.89	209.3	15.87	1.211	33.62	33.92	219.9	16.00	1.189
15,000	13.72	11.15	240.7	17.47	1.235	38.47	38.79	252.6	17.61	1.185
16.000	14.63	11.67	275.0	18.62	1.266	43.65	43.99	287.8	18.75	1.177
17,000	15.55	12.27	311.7	19.53	1.301	49.19	49.53	325.5	19.66	1.168
18,000	16.46	12.89	350.8	20.30	1.340	55.06	55.41	365.5	20.42	1.160
19,000	17.38	13.51	392.3	21.00	1.383	61.26	61.63	407.9	21.11	1.153
20,000	18.29	14.10	436.0	21.64	1.428	67.82	68.17	452.7	21.75	1.146
21,000	19.21	14.66	482.0	22.26	1.477	74.69	75.06	499.6	22.36	1.141
22,000	20.12	15.18	530.2	22.86	1.528	81.91	82.28	548.9	22.96	1.136
23,000	21.04	15.65	580.7	23.47	1.581	89.45	89.84	600.5	23.57	1.132
24,000	21.95	16.06	633.3	24.08	1.637	97.33	97.73	654.3	24.17	1.128
25,000	22.86	16.42	688.1	24.73	1.694	105.5	106.0	710.4	24.82	1.126
26,000	23.78	16.70	744.9	25.44	1.753	114.1	114.5	768.6	25.53	1.124

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 190,000 feet
Pressure: 7.0278×10^{-1} psfa
Density: 8.6517×10^{-7} slugs/ft^3
Temperature: 473.24 °R
Enthalpy: 2.8319×10^{6} ft-lb/slug
Sonic Speed: 1066.4 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	1.875						1.706			
3000	2.813	3.739	9.113	2.437	1.000	2.475	2.589	10.71	2.558	1.385
4000	3.751	4.639	16.44	3.544	1.000	3.693	3.825	18.57	3.670	1.368
5000	4.689	5.298	25.96	4.899	1.000	5.255	5.414	28.86	5.046	1.353
6000	5.626	5.836	37.71	6.461	1.000	7.167	7.356	41.50	6.630	1.337
7000	6.564	6.412	51.89	8.070	1.003	9.441	9.652	56.60	8.250	1.315
8000	7.502	7.260	68.90	9.338	1.016	12.08	12.30	74.33	9.504	1.278
9000	8.440	8.286	88.64	10.27	1.042	15.09	15.30	94.66	10.41	1.243
10,000	9.377	9.312	110.8	11.07	1.076	18.44	18.66	117.4	11.19	1.215
11,000	10.32	10.24	135.3	11.86	1.115	22.16	22.36	142.6	11.97	1.196
12,000	11.25	10.92	162.0	12.82	1.157	26.21	26.42	170.1	12.92	1.184
13,000	12.19	11.10	190.2	14.38	1.192	30.59	30.84	199.6	14.49	1.183
14,000	13.13	10.97	220.2	16.55	1.213	35.30	35.61	231.2	16.69	1.188
15,000	14.07	11.26	253.2	18.19	1.237	40.40	40.73	265.6	18.33	1.184
16,000	15.00	11.79	289.3	19.35	1.268	45.85	46.20	302.6	19.49	1.176
17,000	15.94	12.41	327.9	20.27	1.304	51.68	52.03	342.3	20.40	1.167
18,000	16.88	13.05	369.1	21.06	1.343	57.84	58.21	384.4	21.18	1.158
19,000	17.82	13.68	412.7	21.76	1.386	64.37	64.74	428.9	21.88	1.151
20,000	18.75	14.29	458.7	22.42	1.432	71.26	71.62	476.0	22.53	1.144
21,000	19.69	14.86	507.1	23.05	1.481	78.48	78.86	525.4	23.15	1.139
22,000	20.63	15.39	557.9	23.66	1.532	86.07	86.46	577.2	23.76	1.134
23,000	21.57	15.87	610.9	24.28	1.586	94.00	94.40	631.5	24.37	1.130
24,000	22.51	16.30	666.3	24.91	1.642	102.3	102.7	688.1	25.00	1.127
25,000	23.44	16.66	723.9	25.57	1.699	110.9	111.4	747.0	25.66	1.124
26,000	24.38	16.94	783.7	26.30	1.758	119.9	120.4	808.3	26.39	1.122

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 200,000 feet
Pressure: 4.7151×10^{-1} psfa
Density: 6.1180×10^{-7} slugs/ft^3
Temperature: 449.00°R
Enthalpy: 2.6864×10^{6} ft-lb/slug
Sonic Speed: 1038.7 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	1.925						1.745			
3000	2.888	3.809	9.608	2.523	1.000	2.559	2.675	11.14	2.636	1.387
4000	3.851	4.696	17.33	3.691	1.000	3.842	3.978	19.54	3.820	1.370
5000	4.814	5.343	27.35	5.120	1.000	5.489	5.653	30.39	5.272	1.354
6000	5.776	5.871	39.74	6.768	1.000	7.503	7.700	43.72	6.943	1.338
7000	6.739	6.450	54.70	8.455	1.003	9.898	10.12	59.63	8.642	1.315
8000	7.702	7.322	72.67	9.756	1.017	12.68	12.91	78.34	9.927	1.277
9000	8.665	8.374	93.51	10.70	1.044	15.86	16.08	99.78	10.85	1.241
10,000	9.627	9.421	116.9	11.51	1.078	19.39	19.61	123.8	11.63	1.213
11,000	10.59	10.36	142.8	12.33	1.118	23.30	23.52	150.4	12.44	1.194
12,000	11.55	11.05	170.9	13.33	1.160	27.57	27.80	179.3	13.44	1.182
13,000	12.52	11.19	200.6	15.00	1.195	32.19	32.46	210.4	15.10	1.182
14,000	13.48	11.05	232.2	17.30	1.215	37.17	37.48	243.7	17.44	1.187
15,000	14.44	11.36	267.1	18.97	1.239	42.53	42.88	280.0	19.11	1.182
16,000	15.40	11.92	305.1	20.15	1.270	48.30	48.65	319.1	20.29	1.174
17,000	16.37	12.56	346.0	21.08	1.306	54.43	54.79	360.9	21.21	1.165
18,000	17.33	13.22	389.4	21.88	1.346	60.93	61.31	405.3	22.00	1.156
19,000	18.29	13.87	435.4	22.60	1.389	67.81	68.19	452.3	22.72	1.149
20,000	19.25	14.49	483.9	23.27	1.436	75.06	75.45	501.8	23.38	1.142
21,000	20.22	15.07	535.0	23.91	1.485	82.68	83.08	554.0	24.02	1.137
22,000	21.18	15.61	588.5	24.54	1.536	90.69	91.09	608.6	24.64	1.132
23,000	22.14	16.10	644.5	25.16	1.590	99.06	99.46	665.8	25.26	1.128
24,000	23.11	16.54	702.9	25.81	1.646	107.8	108.2	725.4	25.90	1.125
25,000	24.07	16.91	763.7	26.49	1.705	116.9	117.3	787.6	26.58	1.122
26,000	25.03	17.20	826.8	27.25	1.764	126.4	126.8	852.3	27.34	1.120

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 210,000 feet
Pressure: 3.0955×10^{-1} psfa
Density: 4.2454×10^{-7} slugs/ft^3
Temperature: 424.79°R
Enthalpy: 2.5413×10^{6} ft-lb/slug
Sonic Speed: 1010.3 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	1.980						1.787			
3000	2.969						2.771			
4000	3.959	4.755	18.32	3.853	1.000	4.008	4.148	20.63	3.987	1.371
5000	4.949	5.388	28.91	5.366	1.000	5.748	5.919	32.09	5.524	1.356
6000	5.939	5.906	42.00	7.110	1.000	7.877	8.083	46.17	7.293	1.339
7000	6.929	6.490	57.82	8.880	1.003	10.40	10.64	63.00	9.076	1.315
8000	7.918	7.388	76.86	10.21	1.018	13.35	13.59	82.80	10.39	1.276
9000	8.908	8.467	98.93	11.18	1.045	16.71	16.94	105.1	11.33	1.239
10,000	9.898	9.537	123.7	12.01	1.080	20.46	20.68	130.9	12.14	1.211
11,000	10.89	10.50	151.1	12.84	1.121	24.58	24.81	159.0	12.95	1.192
12,000	11.88	11.19	180.8	13.89	1.163	29.10	29.33	189.6	14.00	1.181
13,000	12.87	11.29	212.1	15.71	1.197	33.98	34.25	222.4	15.83	1.181
14,000	13.86	11.13	245.5	18.14	1.216	39.24	39.56	257.6	18.28	1.186
15,000	14.85	11.48	282.6	19.83	1.241	44.91	45.27	296.0	19.98	1.181
16,000	15.84	12.06	322.8	21.03	1.273	51.00	51.37	337.4	21.17	1.172
17,000	16.83	12.72	366.0	21.98	1.309	57.49	57.86	381.6	22.11	1.163
18,000	17.82	13.40	412.0	22.79	1.349	64.37	64.75	428.5	22.92	1.155
19,000	18.81	14.06	460.7	23.52	1.393	71.64	72.03	478.2	23.64	1.147
20,000	19.80	14.70	512.0	24.21	1.439	79.30	79.70	530.6	24.32	1.141
21,000	20.79	15.29	566.0	24.86	1.489	87.36	87.77	585.7	24.96	1.135
22,000	21.78	15.85	622.6	25.50	1.541	95.82	96.23	643.5	25.60	1.130
23,000	22.77	16.35	681.8	26.14	1.595	104.7	105.1	704.0	26.24	1.126
24,000	23.76	16.80	743.6	26.80	1.651	113.9	114.3	767.1	26.89	1.123
25,000	24.75	17.18	807.9	27.51	1.710	123.5	124.0	832.9	27.60	1.120
26,000	25.73	17.47	874.7	28.28	1.770	133.5	134.0	901.2	28.38	1.118

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 220,000 feet — Temperature: 400.60°R

Pressure: 1.9835×10^{-1} psfa — Enthalpy: 2.3966×10^{6} ft-lb/slug

Density: 2.8845×10^{-7} slugs/ft^3 — Sonic Speed: 981.16 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	2.038						1.835			
3000	3.058						2.878			
4000	4.077	4.815	19.43	4.035	1.000	4.193	4.338	21.84	4.174	1.372
5000	5.096	5.434	30.65	5.641	1.000	6.037	6.216	34.00	5.806	1.357
6000	6.115	5.942	44.52	7.492	1.000	8.295	8.511	48.93	7.685	1.340
7000	7.134	6.532	61.32	9.354	1.004	10.98	11.22	66.78	9.559	1.315
8000	8.154	7.459	81.56	10.72	1.020	14.12	14.35	87.80	10.90	1.275
9000	9.173	8.567	105.0	11.70	1.047	17.66	17.90	111.9	11.85	1.237
10,000	10.19	9.661	131.3	12.55	1.083	21.63	21.86	138.8	12.68	1.209
11,000	11.21	10.64	160.4	13.41	1.124	26.01	26.24	168.6	13.53	1.190
12,000	12.23	11.34	191.9	14.51	1.167	30.80	31.04	201.1	14.62	1.179
13,000	13.25	11.38	225.1	16.50	1.199	35.97	36.26	235.9	16.63	1.180
14,000	14.27	11.22	260.5	19.06	1.218	41.55	41.89	273.2	19.21	1.185
15,000	15.29	11.60	299.8	20.79	1.243	47.57	47.94	313.9	20.94	1.179
16,000	16.31	12.21	342.6	22.00	1.275	54.03	54.41	357.9	22.15	1.170
17,000	17.33	12.89	388.5	22.97	1.312	60.90	61.29	404.8	23.11	1.161
18,000	18.35	13.59	437.3	23.80	1.353	68.20	68.60	454.6	23.93	1.153
19,000	19.36	14.27	488.9	24.54	1.396	75.91	76.32	507.3	24.66	1.145
20,000	20.38	14.92	543.4	25.24	1.443	84.04	84.45	562.9	25.35	1.139
21,000	21.40	15.53	600.7	25.91	1.493	92.60	93.01	621.4	26.02	1.133
22,000	22.42	16.10	660.8	26.56	1.545	101.6	102.0	682.8	26.66	1.128
23,000	23.44	16.62	723.7	27.22	1.600	110.9	111.4	746.8	27.32	1.124
24,000	24.46	17.08	789.2	27.90	1.657	120.7	121.2	813.8	28.01	1.121
25,000	25.48	17.46	857.5	28.63	1.715	130.9	131.4	883.5	28.72	1.118
26,000	26.50	17.77	928.3	29.43	1.776	141.6	142.0	956.0	29.52	1.116

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 230,000 feet
Pressure: 1.2368×10^{-1} psfa
Density: 1.9141×10^{-7} slugs/ft^3
Temperature: 376.44°R
Enthalpy: 2.2519×10^{6} ft-lb/slug
Sonic Speed: 951.11 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	2.103						1.888			
3000	3.154						2.998			
4000	4.206	4.876	20.68	4.240	1.000	4.402	4.553	23.21	4.384	1.374
5000	5.257	5.480	32.62	5.952	1.000	6.364	6.551	36.15	6.124	1.358
6000	6.308	5.978	47.37	7.924	1.000	8.776	8.993	52.03	8.126	1.341
7000	7.360	6.577	65.28	9.885	1.004	11.63	11.88	71.04	10.10	1.315
8000	8.411	7.536	86.87	11.29	1.021	14.96	15.21	93.44	11.48	1.273
9000	9.463	8.668	111.8	12.30	1.050	18.75	18.98	119.1	12.46	1.236
10,000	10.51	9.791	139.9	13.16	1.086	22.97	23.20	147.8	13.29	1.207
11,000	11.57	10.79	170.8	14.05	1.127	27.62	27.87	179.5	14.17	1.187
12,000	12.62	11.49	204.4	15.21	1.170	32.72	32.97	214.1	15.32	1.177
13,000	13.67	11.47	239.6	17.39	1.201	38.23	38.52	251.1	17.52	1.179
14,000	14.72	11.32	277.4	20.09	1.219	44.16	44.52	290.8	20.24	1.184
15,000	15.77	11.74	319.4	21.85	1.245	50.57	50.96	334.2	22.01	1.178
16,000	16.82	12.37	365.0	23.09	1.278	57.45	57.84	382.4	23.24	1.168
17,000	17.87	13.07	413.8	24.07	1.315	64.76	65.17	430.9	24.21	1.159
18,000	18.92	13.79	465.8	24.92	1.356	72.53	72.94	484.0	25.05	1.150
19,000	19.98	14.49	520.9	25.68	1.400	80.74	81.15	540.1	25.80	1.143
20,000	21.03	15.16	578.9	26.39	1.447	89.40	89.81	599.4	26.50	1.136
21,000	22.08	15.79	640.0	27.08	1.497	98.49	98.92	661.6	27.19	1.131
22,000	23.13	16.37	703.9	27.75	1.550	108.0	109.5	726.8	27.85	1.126
23,000	24.18	16.90	770.9	28.43	1.605	118.0	118.5	795.1	28.53	1.122
24,000	25.23	17.37	840.7	29.13	1.662	128.4	128.9	866.4	29.23	1.119
25,000	26.29	17.77	913.4	29.87	1.721	139.3	139.8	940.6	29.96	1.116
26,000	27.34	18.08	988.9	30.71	1.782	150.6	151.1	1018.	30.81	1.114

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 240,000 feet
Pressure: 7.4774×10^{-2} psfa
Density: 1.2365×10^{-7} slugs/ft^3
Temperature: 352.30°R
Enthalpy: 2.1076×10^{6} ft-lb/slug
Sonic Speed: 920.11 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	2.174						1.949			
3000	3.260						3.135			
4000	4.347	4.939	22.09	4.473	1.000	4.639	4.796	24.78	4.623	1.375
5000	5.434	5.528	34.85	6.304	1.000	6.735	6.931	38.60	6.481	1.359
6000	6.521	6.015	50.61	8.413	1.000	9.302	9.541	55.58	8.621	1.342
7000	7.608	6.626	69.77	10.48	1.004	12.36	12.62	75.92	10.70	1.315
8000	8.695	7.619	92.90	11.93	1.022	15.91	16.18	99.86	12.13	1.272
9000	9.781	8.782	119.6	12.95	1.052	19.96	20.22	127.3	13.11	1.233
10,000	10.87	9.933	149.7	13.84	1.088	24.48	24.72	158.2	13.97	1.205
11,000	11.96	10.95	182.7	14.76	1.130	29.46	29.71	192.1	14.88	1.186
12,000	13.04	11.65	218.6	15.99	1.173	34.90	35.16	228.8	16.11	1.175
13,000	14.13	11.56	256.2	18.41	1.203	40.78	41.09	268.5	18.55	1.178
14,000	15.22	11.43	296.6	21.25	1.221	47.12	47.50	311.0	21.41	1.182
15,000	16.30	11.88	341.6	23.05	1.248	53.98	54.38	357.3	23.21	1.176
16,000	17.39	12.54	390.4	24.30	1.281	61.32	61.73	407.5	24.45	1.166
17,000	18.48	13.27	442.7	25.31	1.318	69.14	69.56	461.1	25.45	1.157
18,000	19.56	14.00	498.3	26.17	1.359	77.45	77.87	517.5	26.30	1.148
19,000	20.65	14.72	557.1	26.95	1.404	86.22	86.64	577.7	27.07	1.141
20,000	21.74	15.41	619.2	27.69	1.451	95.46	95.90	641.1	27.81	1.134
21,000	22.82	16.06	684.5	28.39	1.501	105.2	105.6	707.4	28.50	1.129
22,000	23.91	16.66	753.0	29.08	1.554	115.4	115.8	785.4	29.18	1.124
23,000	25.00	17.20	824.5	29.77	1.610	126.0	126.5	850.6	29.87	1.120
24,000	26.08	17.69	899.3	30.50	1.667	137.1	137.6	926.4	30.60	1.117
25,000	27.17	18.09	977.0	31.27	1.727	148.8	149.3	1005.	31.36	1.114
26,000	28.26	18.41	1058.	32.14	1.788	160.9	161.4	1089.	32.23	1.112

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 250,000 feet — Temperature: 328.2°R

Pressure: 4.364×10^{-2} psfa — Enthalpy: 1.9636×10^{6} ft-lb/slug

Density: 7.748×10^{-8} slugs/ft^3 — Sonic Speed: 888.11 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	2.252						2.019			
3000	3.378						3.292			
4000	4.504	5.004	23.72	4.740	1.000	4.910	5.074	26.55	4.897	1.376
5000	5.630	5.576	37.40	6.708	1.000	7.159	7.366	41.38	6.899	1.360
6000	6.756	6.053	54.32	8.974	1.000	9.912	10.17	59.60	9.200	1.343
7000	7.882	6.678	74.92	11.16	1.005	13.13	13.20	81.44	11.40	1.314
8000	9.008	7.711	99.83	12.64	1.024	17.02	17.30	107.2	12.85	1.270
9000	10.13	8.907	128.6	13.70	1.054	21.35	21.63	136.7	13.87	1.231
10,000	11.26	10.09	160.8	14.61	1.091	26.19	26.46	169.6	14.76	1.203
11,000	12.39	11.13	196.4	15.57	1.134	31.56	31.81	206.1	15.69	1.183
12,000	13.51	11.82	234.9	16.88	1.177	37.41	37.67	245.7	17.00	1.173
13,000	14.64	11.65	275.1	19.59	1.205	43.71	44.03	288.0	19.73	1.178
14,000	15.76	11.54	318.6	22.57	1.223	50.51	50.91	333.7	22.74	1.181
15,000	16.89	12.04	367.0	24.40	1.250	57.88	58.29	383.6	24.57	1.174
16,000	18.02	12.73	419.5	25.68	1.284	65.78	66.19	437.3	25.84	1.164
17,000	19.14	13.48	475.7	26.71	1.321	74.15	74.59	494.7	26.86	1.154
18,000	20.27	14.24	535.5	27.59	1.363	83.06	83.50	555.7	27.73	1.146
19,000	21.39	14.98	598.7	28.39	1.408	92.48	92.93	620.1	28.51	1.138
20,000	22.52	15.69	665.4	29.[illegible]	1.456	102.4	102.9	688.1	29.27	1.132
21,000	23.65	16.35	735.6	29.87	1.506	112.8	113.3	759.5	29.98	1.126
22,000	24.77	16.97	809.1	30.58	1.559	123.8	124.2	834.5	30.69	1.122
23,000	25.90	17.53	886.0	31.30	1.615	135.2	135.7	912.8	31.40	1.118
24,000	27.02	18.03	966.3	32.04	1.673	147.2	147.7	994.6	32.14	1.115
25,000	28.15	18.45	1050.	32.85	1.733	159.6	160.1	1080.	32.95	1.112
26,000	29.28	18.77	1137.	33.76	1.794	172.6	173.1	1169.	33.85	1.110

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 260,000 feet
Pressure: 2.446×10^{-2} psfa
Density: 4.686×10^{-8} slugs/ft^3
Temperature: 304.1°R
Enthalpy: 1.8198×10^{6} ft-lb/slug
Sonic Speed: 854.8 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	2.340						2.099			
3000	3.510						3.473			
4000	4.679	5.070	25.60	5.048	1.000	5.224	5.396	28.62	5.213	1.378
5000	5.849	5.626	40.36	7.175	1.000	7.650	7.869	44.62	7.379	1.361
6000	7.019	6.091	58.62	9.622	1.000	10.62	10.89	64.28	9.864	1.344
7000	8.189	6.736	80.90	11.94	1.006	14.16	14.46	87.87	12.20	1.314
8000	9.359	7.810	107.9	13.47	1.026	18.29	18.59	115.7	13.68	1.267
9000	10.53	9.042	139.0	14.55	1.057	22.99	23.26	147.5	14.73	1.228
10,000	11.70	10.25	173.8	15.49	1.094	28.19	28.48	183.2	15.63	1.200
11,000	12.87	11.32	212.2	16.49	1.137	33.97	34.25	222.5	16.62	1.181
12,000	14.04	12.01	253.8	17.91	1.180	40.26	40.57	265.3	18.03	1.171
13,000	15.21	11.74	297.1	20.96	1.207	47.09	47.44	310.9	21.11	1.177
14,000	16.38	11.67	344.2	24.08	1.225	54.45	54.85	360.3	24.26	1.179
15,000	17.55	12.21	396.6	25.94	1.253	62.41	62.82	414.2	26.11	1.171
16,000	18.72	12.93	453.3	27.25	1.287	70.91	71.34	472.2	27.41	1.161
17,000	19.89	13.71	514.1	28.30	1.325	79.96	80.41	534.3	28.45	1.152
18,000	21.06	14.49	578.6	29.21	1.367	89.57	90.02	600.0	29.35	1.143
19,000	22.23	15.25	647.0	30.04	1.412	99.74	100.2	668.6	30.17	1.136
20,000	23.40	15.98	719.1	30.81	1.460	110.4	110.9	743.0	30.93	1.130
21,000	24.57	16.67	794.8	31.56	1.511	121.7	122.2	822.2	31.67	1.124
22,000	25.74	17.31	874.3	32.29	1.564	133.5	134.0	901.0	32.40	1.119
23,000	26.91	17.89	957.4	33.04	1.620	145.8	146.4	985.7	33.14	1.116
24,000	28.08	18.40	1044.	33.81	1.678	158.7	159.3	1074.	33.91	1.112
25,000	29.25	18.83	1134.	34.65	1.739	172.2	172.7	1166.	34.75	1.110
26,000	30.42	19.16	1228.	35.60	1.800	186.2	186.7	1262.	35.70	1.108

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 270,000 feet
Pressure: 1.327×10^{-2} psfa
Density: 2.593×10^{-8} slugs/ft^3
Temperature: 298.2°R
Enthalpy: 1.7847×10^{6} ft-lb/slug
Sonic Speed: 846.5 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	2.363						2.121			
3000	3.544						3.522			
4000	4.725	5.087	26.10	5.131	1.000	5.308	5.483	29.17	5.299	1.378
5000	5.907	5.638	41.16	7.301	1.000	7.782	8.004	45.49	7.507	1.362
6000	7.088	6.103	59.78	9.793	1.000	10.81	11.09	65.54	10.04	1.344
7000	8.269	6.790	82.59	12.08	1.007	14.43	14.73	89.64	12.33	1.311
8000	9.451	7.921	110.2	13.53	1.028	18.64	18.93	118.1	13.74	1.263
9000	10.63	9.196	142.0	14.57	1.060	23.42	23.69	150.6	14.74	1.224
10,000	11.81	10.44	177.6	15.48	1.099	28.76	29.02	186.9	15.62	1.196
11,000	12.99	11.53	216.8	16.46	1.142	34.65	34.90	227.0	16.58	1.177
12,000	14.18	12.20	259.2	17.92	1.185	41.07	41.35	270.7	18.04	1.168
13,000	15.36	11.82	303.1	21.21	1.208	47.98	48.35	317.1	21.36	1.176
14,000	16.54	11.82	351.3	24.23	1.227	55.50	55.91	367.5	24.40	1.177
15,000	17.72	12.40	404.9	26.00	1.256	63.62	64.04	422.7	26.17	1.168
16,000	18.90	13.17	462.9	27.25	1.290	72.27	72.73	481.9	27.41	1.158
17,000	20.08	13.98	525.0	28.26	1.329	81.52	81.97	545.2	28.40	1.149
18,000	21.26	14.79	590.9	29.14	1.371	91.31	91.78	612.3	29.27	1.140
19,000	22.44	15.58	660.7	29.94	1.417	101.7	102.1	683.4	30.06	1.133
20,000	23.63	16.33	734.3	30.68	1.465	112.6	113.1	758.2	30.79	1.127
21,000	24.81	17.04	811.6	31.41	1.516	124.1	124.6	836.9	31.52	1.121
22,000	25.99	17.70	892.7	32.12	1.570	136.1	136.6	919.4	32.22	1.117
23,000	27.17	18.30	977.6	32.84	1.627	148.7	149.2	1006.	32.94	1.113
24,000	28.35	18.83	1066.	33.60	1.685	161.9	162.4	1096.	33.69	1.110
25,000	29.53	19.27	1158.	34.42	1.746	175.6	176.1	1190.	34.51	1.107
26,000	30.71	19.61	1254.	35.36	1.808	189.8	190.4	1288.	35.45	1.105

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 280,000 feet Temperature: 298.2 °R

Pressure: 7.194×10^{-3} psfa Enthalpy: 1.7847×10^{6} ft-lb/slug

Density: 1.406×10^{-8} slugs/ft^3 Sonic Speed: 846.5 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	2.363						2.121			
3000	3.544						3.522			
4000	4.725	5.087	26.10	5.131	1.000	5.308	5.483	29.17	5.299	1.378
5000	5.907	5.638	41.16	7.301	1.000	7.782	8.004	45.49	7.507	1.362
6000	7.088	6.107	59.79	9.787	1.000	10.81	11.09	65.55	10.03	1.344
7000	8.269	6.847	82.71	11.98	1.008	14.43	14.73	89.70	12.23	1.308
8000	9.451	8.038	110.4	13.33	1.031	18.65	18.93	118.2	13.53	1.259
9000	10.63	9.356	142.3	14.30	1.063	23.42	23.69	150.7	14.46	1.220
10,000	11.81	10.64	177.9	15.17	1.103	28.77	29.02	187.1	15.30	1.192
11,000	12.99	11.75	217.2	16.12	1.146	34.63	34.90	227.2	16.23	1.173
12,000	14.18	12.40	259.5	17.61	1.189	41.07	41.35	270.9	17.72	1.165
13,000	15.36	11.90	303.3	21.07	1.210	48.00	48.35	317.2	21.22	1.174
14,000	16.54	11.97	351.8	23.90	1.230	55.53	55.91	367.8	24.06	1.174
15,000	17.72	12.61	405.5	25.54	1.259	63.62	64.04	423.0	25.70	1.165
16,000	18.90	13.41	463.6	26.71	1.294	72.30	72.73	482.3	26.86	1.155
17,000	20.08	14.25	525.8	27.66	1.333	81.53	81.97	545.6	27.80	1.146
18,000	21.26	15.09	591.8	28.49	1.376	91.35	91.78	612.7	28.62	1.137
19,000	22.45	15.91	661.6	29.25	1.422	101.7	102.1	683.8	29.36	1.130
20,000	23.63	16.69	735.3	29.95	1.471	112.7	113.1	758.7	30.06	1.124
21,000	24.81	17.43	812.8	30.64	1.522	124.1	124.6	837.5	30.74	1.118
22,000	25.99	18.11	893.9	31.32	1.576	136.1	136.6	920.1	31.41	1.114
23,000	27.17	18.73	978.9	32.00	1.633	148.7	149.2	1007.	32.09	1.110
24,000	28.35	19.28	1067.	32.73	1.692	161.9	162.4	1097.	32.82	1.107
25,000	29.53	19.74	1160.	33.52	1.753	175.6	176.1	1191.	33.61	1.104
26,000	30.71	20.09	1255.	34.43	1.815	189.9	190.4	1288.	34.51	1.103

TABLE II - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 290,000 feet
Pressure: 8.902×10^{-3} psfa
Density: 7.624×10^{-9} slugs/ft^3
Temperature: 298.2°R
Enthalpy: 1.7847×10^{6} ft-lb/slug
Sonic Speed: 846.5 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	2.363						2.121			
3000	3.544						3.522			
4000	4.725	5.087	26.10	5.131	1.000	5.308	5.483	29.17	5.299	1.378
5000	5.907	5.638	41.16	7.301	1.000	7.782	8.004	45.49	7.507	1.362
6000	7.088	6.113	59.80	9.779	1.000	10.81	11.09	65.55	10.02	1.344
7000	8.269	6.911	82.84	11.88	1.009	14.43	14.73	89.76	12.11	1.304
8000	9.451	8.158	110.7	13.12	1.033	18.65	18.93	118.3	13.32	1.254
9000	10.63	9.519	142.6	14.04	1.067	23.44	23.69	150.9	14.19	1.215
10,000	11.81	10.84	178.3	14.86	1.107	28.77	29.02	187.3	14.98	1.188
11,000	12.99	11.98	217.6	15.78	1.151	34.66	34.90	227.4	15.89	1.169
12,000	14.18	12.58	259.8	17.32	1.193	41.07	41.35	271.0	17.43	1.162
13,000	15.36	11.97	303.5	20.92	1.211	47.98	48.35	317.2	21.06	1.173
14,000	16.54	12.13	352.2	23.57	1.232	55.53	55.91	368.0	23.73	1.172
15,000	17.72	12.82	406.1	25.09	1.262	63.63	64.04	423.2	25.24	1.162
16,000	18.90	13.66	464.3	26.19	1.298	72.32	72.73	482.6	26.33	1.152
17,000	20.08	14.53	526.5	27.09	1.337	81.54	81.97	545.9	27.22	1.142
18,000	21.26	15.40	592.6	27.87	1.380	91.34	91.78	613.2	27.99	1.134
19,000	22.45	16.25	662.6	28.58	1.427	101.8	102.1	684.3	28.69	1.127
20,000	23.63	17.06	736.3	29.25	1.476	112.7	113.1	759.2	29.35	1.121
21,000	24.81	17.82	813.8	29.90	1.527	124.1	124.6	838.0	29.99	1.115
22,000	25.99	18.52	895.1	30.55	1.582	136.2	136.6	920.6	30.64	1.111
23,000	27.17	19.16	980.1	31.21	1.639	148.8	149.2	1007.	31.29	1.107
24,000	28.35	19.73	1069.	31.90	1.698	161.9	162.4	1097.	31.98	1.109
25,000	29.53	20.21	1161.	32.65	1.760	175.6	176.1	1191.	32.73	1.102
26,000	30.71	20.56	1257.	33.54	1.822	189.9	190.4	1289.	33.62	1.100

TABLE III - NORMAL-SHOCK WAVE PARAMETERS

Altitude: 300,000 feet
Pressure: 2.118×10^{-3} psfa
Density: 4.123×10^{-9} slugs/ft^3
Temperature: 299.2 °R
Enthalpy: 1.7906×10^{6} ft-lb/slug
Sonic Speed: 848.3 ft/sec

V_1	M_1	ρ_2/ρ_1	p_2/p_1	T_2/T_1	Z_2	H_2/H_1	H_{T_2}/H_1	p_{T_2}/p_1	T_{T_2}/T_1	γ_e
2000	2.358						2.117			
3000	3.538						3.513			
4000	4.716	5.084	26.02	5.117	1.000	5.294	5.468	29.08	5.284	1.378
5000	5.896	5.636	41.02	7.279	1.000	7.759	7.981	45.34	7.485	1.362
6000	7.075	6.118	59.62	9.738	1.001	10.78	11.05	65.34	9.981	1.343
7000	8.254	6.980	82.71	11.72	1.011	14.40	14.68	89.54	11.95	1.300
8000	9.433	8.283	110.5	12.88	1.036	18.61	18.87	118.0	13.06	1.249
9000	10.61	9.685	142.4	13.73	1.070	23.36	23.62	150.5	13.87	1.211
10,000	11.79	11.04	178.0	14.52	1.111	28.70	28.93	186.8	14.64	1.183
11,000	12.97	12.20	217.2	15.41	1.155	34.55	34.79	226.9	15.51	1.166
12,000	14.15	12.74	259.3	17.00	1.196	40.94	41.21	270.3	17.10	1.160
13,000	15.33	12.05	302.6	20.70	1.213	47.86	48.19	316.3	20.84	1.172
14,000	16.51	12.29	351.4	23.16	1.234	55.33	55.73	367.0	23.31	1.169
15,000	17.69	13.04	405.3	24.57	1.265	63.43	63.83	422.1	24.71	1.159
16,000	18.87	13.91	463.4	25.60	1.301	72.08	72.49	481.4	25.73	1.149
17,000	20.05	14.82	525.5	26.44	1.341	81.29	81.70	544.5	26.56	1.139
18,000	21.23	15.72	591.5	27.18	1.385	91.11	91.48	611.5	27.29	1.131
19,000	22.40	16.69	661.3	27.85	1.431	101.4	101.8	682.4	27.95	1.124
20,000	23.58	17.43	734.8	28.49	1.480	112.3	112.7	757.2	28.58	1.118
21,000	24.76	18.21	812.2	29.10	1.533	123.8	124.2	835.8	29.19	1.113
22,000	25.94	18.94	893.3	29.71	1.587	135.7	136.2	918.1	29.79	1.108
23,000	27.12	19.60	978.1	30.34	1.645	148.3	148.7	1004.	30.42	1.105
24,000	28.30	20.19	1067.	31.00	1.704	161.4	161.8	1094.	31.07	1.102
25,000	29.48	20.68	1159.	31.72	1.766	175.1	175.5	1188.	31.79	1.099
26,000	30.66	21.05	1254.	32.58	1.829	189.3	189.8	1285.	32.65	1.098

Altitude: 0 feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000	7.809 (-1)	2.096 (-1)	9.324 (-3)			9.050 (-28)							
3000	7.809 (-1)	2.096 (-1)	9.324 (-3)			8.859 (-18)							
4000	7.809 (-1)	2.096 (-1)	9.324 (-3)	2.005 (-5)	3.833 (-24)	4.123 (-12)							
5000	7.809 (-1)	2.096 (-1)	9.324 (-3)	4.488 (-4)	3.879 (-17)	1.916 (-8)							
6000	7.785 (-1)	2.082 (-1)	9.324 (-3)	3.250 (-3)	1.184 (-12)	4.211 (-6)							
7000	7.748 (-1)	2.037 (-1)	9.323 (-3)	1.205 (-2)	1.132 (-9)	1.485 (-4)							
8000	7.656 (-1)	1.942 (-1)	9.316 (-3)	2.918 (-2)	1.278 (-7)	1.684 (-3)							
9000	7.511 (-1)	1.781 (-1)	9.282 (-3)	5.267 (-2)	3.514 (-6)	8.923 (-3)							
10.000	7.319 (-1)	1.550 (-1)	9.196 (-3)	7.640 (-2)	3.613 (-5)	2.747 (-2)							
11.000	7.103 (-1)	1.267 (-1)	9.069 (-3)	9.490 (-2)	1.975 (-4)	5.888 (-2)							
12.000	6.882 (-1)	9.624 (-2)	8.858 (-3)	1.056 (-1)	7.459 (-4)	1.003 (-1)							
13.000	6.676 (-1)	6.692 (-2)	8.630 (-3)	1.080 (-1)	2.286 (-3)	1.465 (-1)	7.626 (-6)	4.531 (-10)	5.317 (-8)	1.035 (-5)	1.456 (-11)	1.599 (-9)	2.777 (-6)
14.000	6.494 (-1)	4.217 (-2)	8.403 (-3)	1.025 (-1)	6.208 (-3)	1.913 (-1)	2.141 (-5)	5.043 (-9)	1.684 (-7)	2.808 (-5)	3.860 (-10)	1.467 (-8)	6.866 (-6)
15.000	6.325 (-1)	2.457 (-2)	8.191 (-3)	9.166 (-2)	1.524 (-2)	2.277 (-1)	5.342 (-5)	4.529 (-8)	4.276 (-7)	6.693 (-5)	6.087 (-9)	1.072 (-7)	1.410 (-5)
16.000	6.136 (-1)	1.422 (-2)	7.996 (-3)	7.938 (-2)	3.272 (-2)	2.519 (-1)	1.155 (-4)	3.002 (-7)	8.830 (-7)	1.381 (-4)	7.145 (-8)	5.590 (-7)	2.441 (-5)
17.000	5.896 (-1)	8.761 (-3)	7.808 (-3)	6.856 (-2)	5.981 (-2)	2.650 (-1)	2.133 (-4)	1.368 (-6)	1.520 (-6)	2.446 (-4)	5.129 (-7)	2.059 (-6)	3.868 (-5)
18.000	5.602 (-1)	5.859 (-3)	7.616 (-3)	5.984 (-2)	9.498 (-2)	2.707 (-1)	3.451 (-4)	4.451 (-6)	2.282 (-6)	3.802 (-4)	2.387 (-6)	5.649 (-6)	4.988 (-5)
19.000	5.257 (-1)	4.199 (-3)	7.418 (-3)	5.280 (-2)	1.358 (-1)	2.720 (-1)	5.078 (-4)	1.122 (-5)	3.117 (-6)	5.364 (-4)	8.639 (-6)	1.250 (-5)	6.356 (-5)
20.000	4.903 (-1)	3.166 (-3)	7.215 (-3)	4.697 (-2)	1.802 (-1)	2.706 (-1)	7.004 (-4)	2.358 (-5)	3.985 (-6)	7.052 (-4)	2.150 (-5)	2.377 (-5)	7.768 (-5)
21.000	4.524 (-1)	2.477 (-3)	7.011 (-3)	4.198 (-2)	2.266 (-1)	2.675 (-1)	9.247 (-4)	4.313 (-5)	4.861 (-6)	8.757 (-4)	4.872 (-5)	4.057 (-5)	9.226 (-5)
22.000	4.136 (-1)	1.891 (-3)	6.806 (-3)	3.760 (-2)	2.739 (-1)	2.635 (-1)	1.185 (-3)	7.144 (-5)	5.725 (-6)	1.054 (-3)	9.775 (-5)	6.401 (-5)	1.076 (-4)
23.000	3.767 (-1)	1.431 (-3)	6.604 (-3)	3.370 (-2)	3.214 (-1)	2.588 (-1)	1.489 (-3)	1.094 (-4)	6.564 (-6)	1.222 (-3)	1.789 (-4)	9.523 (-5)	1.289 (-4)
24.000	3.362 (-1)	1.055 (-3)	6.405 (-3)	3.015 (-2)	3.682 (-1)	2.537 (-1)	1.845 (-3)	1.575 (-4)	7.372 (-6)	1.380 (-3)	3.058 (-4)	1.356 (-4)	1.485 (-4)
25.000	2.984 (-1)	1.137 (-3)	6.210 (-3)	2.690 (-2)	4.141 (-1)	2.484 (-1)	2.267 (-3)	2.156 (-4)	8.146 (-6)	1.524 (-3)	4.933 (-4)	1.867 (-4)	1.606 (-4)
26.000	2.616 (-1)	8.615 (-4)	6.022 (-3)	2.388 (-2)	4.585 (-1)	2.431 (-1)	2.773 (-3)	2.831 (-4)	8.891 (-6)	1.648 (-3)	7.641 (-4)	2.508 (-4)	1.687 (-4)

Altitude: 10,000 feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000	7.809 (-1)	2.098 (-1)	9.324 (-3)			7.348 (-25)							
3000	7.806 (-1)	2.098 (-1)	9.324 (-3)			1.710 (-18)							
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)	1.639 (-5)	1.542 (-29)	2.732 (-12)							
5000	7.807 (-1)	2.096 (-1)	9.324 (-3)	4.033 (-4)	2.628 (-17)	1.676 (-8)							
6000	7.799 (-1)	2.083 (-1)	9.324 (-3)	3.073 (-3)	1.024 (-12)	4.186 (-6)							
7000	7.750 (-1)	2.039 (-1)	9.323 (-3)	1.166 (-2)	1.105 (-9)	1.575 (-4)							
8000	7.659 (-1)	1.944 (-1)	9.315 (-3)	2.855 (-2)	1.320 (-7)	1.840 (-3)							
9000	7.512 (-1)	1.780 (-1)	9.278 (-3)	5.163 (-2)	3.672 (-6)	9.804 (-3)							
10,000	7.319 (-1)	1.544 (-1)	9.184 (-3)	7.458 (-2)	3.724 (-5)	2.992 (-2)							
11,000	7.100 (-1)	1.254 (-1)	9.028 (-3)	9.205 (-2)	2.000 (-4)	6.333 (-2)							
12,000	6.877 (-1)	8.432 (-2)	8.823 (-3)	1.017 (-1)	7.466 (-4)	1.067 (-1)							
13,000	6.670 (-1)	6.452 (-2)	8.593 (-3)	1.031 (-1)	2.234 (-3)	1.545 (-1)							
14,000	6.487 (-1)	3.964 (-2)	8.362 (-3)	9.686 (-2)	6.257 (-3)	2.001 (-1)	2.133 (-5)	4.250 (-9)	1.488 (-7)	2.685 (-5)	3.049 (-10)	1.406 (-8)	5.688 (-6)
15,000	6.318 (-1)	2.236 (-2)	8.149 (-3)	8.549 (-2)	1.560 (-2)	2.364 (-1)	5.354 (-5)	3.990 (-8)	3.784 (-7)	6.461 (-5)	5.688 (-9)	1.038 (-7)	1.160 (-5)
16,000	6.177 (-1)	1.256 (-2)	7.955 (-3)	7.316 (-2)	3.387 (-2)	2.595 (-1)	1.161 (-4)	2.740 (-7)	7.809 (-7)	1.343 (-4)	6.974 (-8)	5.539 (-7)	1.988 (-5)
17,000	5.880 (-1)	7.625 (-3)	7.767 (-3)	6.269 (-2)	6.210 (-2)	2.713 (-1)	2.134 (-4)	1.267 (-6)	1.335 (-6)	2.379 (-4)	5.101 (-7)	2.057 (-6)	2.959 (-5)
18,000	5.578 (-1)	5.055 (-3)	7.575 (-3)	5.443 (-2)	9.843 (-2)	2.759 (-1)	3.429 (-4)	4.131 (-6)	2.003 (-6)	3.686 (-4)	2.882 (-6)	5.694 (-6)	3.986 (-5)
19,000	5.235 (-1)	3.603 (-3)	7.377 (-3)	4.786 (-2)	1.403 (-1)	2.763 (-1)	5.011 (-4)	1.040 (-5)	2.725 (-6)	5.179 (-4)	8.012 (-6)	1.246 (-5)	5.041 (-6)
20,000	4.869 (-1)	2.707 (-3)	7.174 (-3)	4.245 (-2)	1.856 (-1)	2.742 (-1)	6.870 (-4)	2.176 (-5)	3.474 (-6)	6.780 (-4)	2.138 (-5)	2.364 (-5)	6.822 (-5)
21,000	4.478 (-1)	2.112 (-3)	6.968 (-3)	3.764 (-2)	2.328 (-1)	2.706 (-1)	9.027 (-4)	3.980 (-5)	4.227 (-6)	8.424 (-4)	4.680 (-5)	4.080 (-6)	7.241 (-5)
22,000	4.085 (-1)	1.692 (-3)	6.763 (-3)	3.382 (-2)	2.808 (-1)	2.660 (-1)	1.153 (-3)	6.584 (-5)	4.968 (-6)	1.005 (-3)	8.706 (-5)	6.358 (-5)	8.816 (-5)
23,000	3.692 (-1)	1.382 (-3)	6.560 (-3)	3.022 (-2)	3.287 (-1)	2.609 (-1)	1.444 (-3)	1.007 (-4)	5.685 (-6)	1.162 (-3)	1.777 (-4)	8.449 (-5)	8.958 (-5)
24,000	3.302 (-1)	1.145 (-3)	6.361 (-3)	2.697 (-2)	3.761 (-1)	2.554 (-1)	1.787 (-3)	1.448 (-4)	6.370 (-6)	1.308 (-3)	3.034 (-4)	1.345 (-4)	9.302 (-6)
25,000	2.921 (-1)	8.56 (-4)	6.166 (-3)	2.399 (-2)	4.223 (-1)	2.498 (-1)	2.194 (-3)	1.980 (-4)	7.022 (-6)	1.438 (-3)	4.908 (-4)	1.852 (-4)	9.256 (-6)
26,000	2.551 (-1)	8.073 (-4)	5.978 (-3)	2.123 (-2)	4.670 (-1)	2.442 (-1)	2.686 (-3)	2.594 (-4)	7.642 (-6)	1.551 (-3)	7.611 (-4)	2.480 (-4)	9.815 (-6)

Altitude: 20,000 feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000	7.809 (-1)	2.098 (-1)	9.324 (-3)			4.769 (-30)							
3000	7.809 (-1)	2.098 (-1)	9.324 (-3)			5.586 (-19)							
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)	1.329 (-5)	6.027 (-25)	1.793 (-12)							
5000	7.807 (-1)	2.096 (-1)	9.324 (-3)	3.631 (-4)	1.776 (-17)	1.470 (-8)							
6000	7.784 (-1)	2.083 (-1)	9.824 (-3)	2.904 (-3)	8.909 (-13)	4.198 (-6)							
7000	7.752 (-1)	2.041 (-1)	9.823 (-3)	1.128 (-2)	1.039 (-9)	1.667 (-4)							
8000	7.661 (-1)	1.946 (-1)	9.315 (-3)	2.792 (-2)	1.375 (-7)	2.930 (-3)							
9000	7.514 (-1)	1.780 (-1)	9.273 (-3)	5.053 (-2)	3.853 (-6)	1.085 (-2)							
10,000	7.318 (-1)	1.537 (-1)	9.171 (-3)	7.260 (-2)	3.838 (-5)	3.273 (-2)							
11,000	7.096 (-1)	1.240 (-1)	9.005 (-3)	8.896 (-2)	2.019 (-4)	6.831 (-2)							
12,000	6.870 (-1)	9.217 (-2)	8.791 (-3)	9.757 (-2)	7.442 (-4)	1.137 (-1)							
13,000	6.662 (-1)	6.190 (-2)	8.553 (-3)	9.800 (-2)	2.276 (-3)	1.631 (-1)							
14,000	6.480 (-1)	3.693 (-2)	8.316 (-3)	9.093 (-2)	6.301 (-3)	2.095 (-1)	2.113 (-5)	3.539 (-9)	1.300 (-7)	2.559 (-5)	2.660 (-10)	1.311 (-8)	9.609 (-6)
15,000	6.312 (-1)	2.008 (-2)	8.105 (-3)	7.907 (-2)	1.601 (-2)	2.459 (-1)	5.349 (-5)	8.501 (-8)	3.313 (-7)	6.235 (-5)	5.310 (-9)	1.004 (-7)	9.382 (-6)
16,000	6.177 (-1)	1.096 (-2)	7.913 (-3)	6.680 (-2)	3.518 (-2)	2.672 (-1)	1.163 (-4)	2.498 (-7)	6.835 (-7)	1.306 (-4)	6.840 (-8)	5.502 (-7)	1.685 (-5)
17,000	5.862 (-1)	6.532 (-3)	7.726 (-3)	5.677 (-2)	6.467 (-2)	2.776 (-1)	2.128 (-4)	1.171 (-6)	1.167 (-6)	2.313 (-4)	5.091 (-7)	2.058 (-6)	2.338 (-5)
18,000	5.551 (-1)	4.294 (-3)	7.534 (-3)	4.905 (-2)	1.022 (-1)	2.810 (-1)	3.394 (-4)	3.820 (-6)	1.737 (-6)	3.569 (-4)	2.380 (-6)	5.638 (-6)	3.144 (-5)
19,000	5.199 (-1)	3.047 (-3)	7.335 (-3)	4.298 (-2)	1.452 (-1)	2.804 (-1)	4.923 (-4)	9.587 (-6)	2.354 (-6)	4.990 (-4)	7.982 (-6)	1.241 (-5)	3.938 (-5)
20,000	4.821 (-1)	2.282 (-3)	7.181 (-3)	3.802 (-2)	1.914 (-1)	2.776 (-1)	6.708 (-4)	2.080 (-5)	2.992 (-6)	6.503 (-4)	2.121 (-5)	2.848 (-5)	4.718 (-5)
21,000	4.429 (-1)	1.775 (-3)	6.925 (-3)	3.380 (-2)	2.394 (-1)	2.734 (-1)	8.770 (-4)	3.689 (-5)	3.632 (-6)	8.045 (-4)	4.788 (-5)	3.994 (-5)	5.565 (-5)
22,000	4.031 (-1)	1.418 (-3)	6.719 (-3)	3.013 (-2)	2.880 (-1)	2.683 (-1)	1.116 (-3)	6.025 (-5)	4.260 (-6)	9.563 (-4)	9.614 (-5)	6.291 (-5)	6.424 (-5)
23,000	3.632 (-1)	1.155 (-3)	6.515 (-3)	2.686 (-2)	3.365 (-1)	2.628 (-1)	1.394 (-3)	9.205 (-5)	4.864 (-6)	1.101 (-3)	1.760 (-4)	9.364 (-5)	7.272 (-5)
24,000	3.239 (-1)	9.541 (-4)	6.316 (-3)	2.390 (-2)	3.843 (-1)	2.569 (-1)	1.722 (-3)	1.322 (-4)	5.439 (-6)	1.234 (-3)	3.008 (-4)	1.332 (-4)	8.291 (-5)
25,000	2.855 (-1)	7.958 (-4)	6.121 (-3)	2.119 (-2)	4.310 (-1)	2.510 (-1)	2.114 (-3)	1.804 (-4)	5.981 (-6)	1.352 (-3)	4.871 (-4)	1.835 (-4)	9.546 (-5)
26,000	2.482 (-1)	6.681 (-4)	5.933 (-3)	1.868 (-2)	4.760 (-1)	2.451 (-1)	2.591 (-3)	2.360 (-4)	6.491 (-6)	1.453 (-3)	7.565 (-4)	2.467 (-4)	1.077 (-4)

Altitude: 30,000 feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000	7.809 (-1)	2.098 (-1)	9.324 (-3)			2.406 (-31)							
3000	7.809 (-1)	2.098 (-1)	9.324 (-3)			1.782 (-19)							
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)	1.070 (-5)	2.292 (-25)	1.167 (-12)							
5000	7.807 (-1)	2.096 (-1)	9.324 (-3)	3.260 (-4)	1.200 (-17)	1.297 (-8)							
6000	7.795 (-1)	2.084 (-1)	9.324 (-3)	2.740 (-3)	7.814 (-13)	4.254 (-6)							
7000	7.754 (-1)	2.042 (-1)	9.323 (-3)	1.091 (-2)	1.084 (-9)	1.829 (-4)							
8000	7.664 (-1)	1.948 (-1)	9.313 (-3)	2.729 (-2)	1.847 (-7)	2.266 (-3)							
9000	7.514 (-1)	1.778 (-1)	9.267 (-3)	4.937 (-2)	4.079 (-6)	1.215 (-2)							
10.000	7.315 (-1)	1.527 (-1)	9.156 (-3)	7.043 (-2)	3.961 (-5)	3.608 (-2)							
11.000	7.090 (-1)	1.222 (-1)	8.978 (-3)	8.557 (-2)	2.033 (-4)	7.402 (-2)							
12.000	6.863 (-1)	8.970 (-2)	8.754 (-3)	9.304 (-2)	7.388 (-4)	1.215 (-1)							
13.000	6.653 (-1)	5.897 (-2)	8.509 (-3)	9.247 (-2)	2.257 (-3)	1.725 (-1)							
14.000	6.472 (-1)	3.405 (-2)	8.271 (-3)	8.468 (-2)	6.341 (-3)	2.194 (-1)	2.031 (-5)	2.909 (-9)	1.121 (-7)	2.432 (-5)	2.297 (-10)	1.216 (-8)	8.698 (-6)
15.000	6.305 (-1)	1.774 (-2)	8.059 (-3)	7.240 (-2)	1.559 (-2)	2.547 (-1)	6.325 (-5)	3.062 (-8)	2.867 (-7)	6.015 (-5)	4.970 (-9)	9.732 (-8)	7.821 (-6)
16.000	6.105 (-1)	9.372 (-3)	7.870 (-3)	6.032 (-2)	3.670 (-2)	2.749 (-1)	1.161 (-4)	2.277 (-7)	5.910 (-7)	1.270 (-4)	6.752 (-8)	5.481 (-7)	1.228 (-5)
17.000	5.842 (-1)	5.493 (-3)	7.684 (-3)	5.084 (-2)	6.755 (-2)	2.837 (-1)	2.114 (-4)	1.079 (-6)	1.004 (-6)	2.247 (-4)	5.101 (-7)	2.061 (-6)	1.791 (-5)
18.000	5.522 (-1)	3.584 (-3)	7.492 (-3)	4.372 (-2)	1.064 (-1)	2.859 (-1)	3.344 (-4)	3.515 (-6)	1.486 (-6)	3.451 (-4)	2.381 (-6)	5.629 (-6)	2.368 (-5)
19.000	5.161 (-1)	2.533 (-3)	7.292 (-3)	3.818 (-2)	1.505 (-1)	2.844 (-1)	4.813 (-4)	8.782 (-6)	2.005 (-6)	4.797 (-4)	7.945 (-6)	1.283 (-5)	2.950 (-5)
20.000	4.775 (-1)	1.892 (-3)	7.087 (-3)	3.368 (-2)	1.977 (-1)	2.808 (-1)	6.516 (-4)	1.624 (-5)	2.541 (-5)	6.219 (-4)	2.106 (-5)	2.325 (-5)	3.541 (-5)
21.000	4.376 (-1)	1.468 (-3)	6.880 (-3)	2.988 (-2)	2.484 (-1)	2.759 (-1)	8.475 (-4)	3.318 (-5)	3.076 (-5)	7.658 (-4)	4.744 (-5)	3.948 (-5)	4.150 (-5)
22.000	3.972 (-1)	1.170 (-3)	6.674 (-3)	2.656 (-2)	2.957 (-1)	2.706 (-1)	1.074 (-3)	5.466 (-5)	3.600 (-4)	9.064 (-4)	9.484 (-5)	6.211 (-5)	4.790 (-5)
23.000	3.569 (-1)	9.501 (-4)	6.470 (-3)	2.361 (-2)	3.448 (-1)	2.644 (-1)	1.338 (-3)	8.337 (-5)	4.103 (-4)	1.039 (-3)	1.738 (-4)	9.232 (-5)	5.476 (-5)
24.000	3.172 (-1)	7.823 (-4)	6.270 (-3)	2.095 (-2)	3.931 (-1)	2.582 (-1)	1.651 (-3)	1.196 (-4)	4.578 (-4)	1.160 (-3)	2.972 (-4)	1.315 (-4)	6.224 (-5)
25.000	2.785 (-1)	6.503 (-4)	6.075 (-3)	1.851 (-2)	4.401 (-1)	2.520 (-1)	2.025 (-3)	1.629 (-4)	5.022 (-4)	1.266 (-3)	4.819 (-4)	1.812 (-4)	6.955 (-5)
26.000	2.409 (-1)	5.439 (-4)	5.887 (-3)	1.626 (-2)	4.854 (-1)	2.459 (-1)	2.486 (-3)	2.128 (-4)	5.436 (-4)	1.353 (-3)	7.489 (-4)	2.430 (-4)	7.994 (-5)

Altitude: 90,000 feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

	MOLE FRACTION CONCENTRATIONS												
V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000	7.859 (-1)	2.098 (-1)	9.324 (-3)			3.643 (-32)							
3000	7.859 (-1)	2.098 (-1)	9.324 (-3)			9.272 (-20)							
4000	7.859 (-1)	2.098 (-1)	9.324 (-3)	9.318 (-6)	1.367 (-25)	9.791 (-13)							
5000	7.857 (-1)	2.096 (-1)	9.324 (-3)	3.046 (-4)	1.034 (-17)	1.321 (-8)							
6000	7.796 (-1)	2.085 (-1)	9.224 (-3)	2.643 (-3)	7.941 (-13)	4.731 (-6)							
7000	7.755 (-1)	2.043 (-1)	9.223 (-3)	1.068 (-2)	1.192 (-9)	2.121 (-4)							
8000	7.664 (-1)	1.948 (-1)	9.312 (-3)	2.683 (-2)	1.627 (-7)	2.659 (-3)							
9000	7.513 (-1)	1.772 (-1)	9.259 (-3)	4.821 (-2)	4.447 (-6)	1.389 (-2)							
10,000	7.310 (-1)	1.512 (-1)	8.135 (-3)	6.801 (-2)	4.138 (-5)	4.048 (-2)							
11,000	7.082 (-1)	1.198 (-1)	8.945 (-3)	8.171 (-2)	2.053 (-4)	6.116 (-2)							
12,000	6.852 (-1)	8.655 (-2)	8.710 (-3)	8.786 (-2)	7.331 (-4)	1.310 (-1)							
13,000	6.641 (-1)	5.540 (-2)	8.458 (-3)	8.620 (-2)	2.241 (-3)	1.836 (-1)							
14,000	6.461 (-1)	3.056 (-2)	8.219 (-3)	7.746 (-2)	6.431 (-3)	2.311 (-1)	2.045 (-5)	2.357 (-9)	9.445 (-8)	2.308 (-5)	1.982 (-10)	1.129 (-8)	2.748 (-6)
15,000	6.295 (-1)	1.509 (-2)	8.007 (-3)	6.483 (-2)	1.719 (-2)	2.652 (-1)	5.310 (-5)	2.683 (-8)	2.425 (-7)	5.820 (-5)	4.746 (-9)	9.552 (-8)	5.464 (-6)
16,000	6.090 (-1)	7.681 (-3)	7.821 (-3)	5.315 (-2)	3.883 (-2)	2.833 (-1)	1.161 (-4)	2.083 (-7)	4.986 (-7)	1.238 (-4)	6.817 (-8)	5,534 (-7)	9.973 (-6)
17,000	5.816 (-1)	4.421 (-3)	7.137 (-3)	4.442 (-2)	7.137 (-2)	2.901 (-1)	2.095 (-4)	9.924 (-7)	8.408 (-7	2.181 (-4)	5.188 (-7)	2.082 (-6)	1.302 (-5)
18,000	5.483 (-1)	2.574 (-3)	7.444 (-3)	3.802 (-2)	1.118 (-1)	2.909 (-1)	3.279 (-4)	3.208 (-6)	1.235 (-6)	3.325 (-4)	2.402 (-6)	5.639 (-6)	1.703 (-5)
19,000	5.112 (-1)	2.025 (-3)	7.243 (-3)	3.310 (-2)	1.571 (-1)	2.883 (-1)	4.676 (-4)	7.947 (-6)	1.657 (-6)	4.588 (-4)	7.935 (-6)	1.226 (-5)	2.104 (-5)
20,000	4.718 (-1)	1.509 (-3)	7.137 (-3)	2.912 (-2)	2.053 (-1)	2.839 (-1)	6.281 (-4)	1.639 (-5)	2.090 (-6)	5.909 (-4)	2.087 (-5)	2.200 (-5)	2.509 (-5)
21,000	4.312 (-1)	1.168 (-3)	6.829 (-3)	2.576 (-2)	2.549 (-1)	2.784 (-1)	8.121 (-4)	2.968 (-5)	2.523 (-6)	7.234 (-4)	4.681 (-5)	3.891 (-5)	2.887 (-5)
22,000	3.902 (-1)	9.286 (-4)	6.522 (-3)	2.284 (-2)	3.048 (-1)	2.724 (-1)	1.024 (-3)	5.365 (-5)	2.946 (-6	8.517 (-4)	9.346 (-5)	6.111 (-5)	3.365 (-5)
23,000	3.494 (-1)	7.522 (-4)	6.418 (-3)	2.024 (-2)	3.546 (-1)	2.660 (-1)	1.272 (-3)	9.837 (-5)	3.350 (-6	9.715 (-4)	1.710 (-4)	9.076 (-5)	3.837 (-5)
24,000	3.093 (-1)	6.174 (-4)	6.218 (-3)	1.790 (-2)	4.033 (-1)	2.594 (-1)	1.567 (-3)	1.355 (-5)	3.729 (-6)	1.079 (-3)	2.925 (-4)	1.283 (-4)	4.356 (-5)
25,000	2.702 (-1)	5.119 (-4)	6.023 (-3)	1.576 (-2)	4.507 (-1)	2.528 (-1)	1.923 (-3)	1.935 (-5)	4.081 (-6)	1.171 (-3)	4.750 (-4)	1.783 (-4)	4.836 (-5)
26,000	2.324 (-1)	4.259 (-4)	5.835 (-3)	1.378 (-2)	4.963 (-1)	2.464 (-1)	2.363 (-3)	2.598 (-5)	4.404 (-6)	1.246 (-3)	7.409 (-4)	2.404 (-4)	5.288 (-5)

Altitude: 50,000 feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000	7.809 (-1)	2.098 (-1)	9.32% (-3)			4.628 (-32)							
3000	7.809 (-1)	2.098 (-1)	9.32% (-3)			1.178 (-19)							
4000	7.808 (-1)	2.098 (-1)	9.32% (-3)	8.319 (-6)	1.737 (-25)	1.244 (-12)							
5000	7.807 (-1)	2.096 (-1)	9.32% (-3)	3.046 (-4)	1.313 (-17)	1.678 (-6)							
6000	7.786 (-1)	2.085 (-1)	9.32% (-3)	2.643 (-3)	1.009 (-12)	6.010 (-6)							
7000	7.754 (-1)	2.083 (-1)	9.323 (-3)	1.067 (-2)	1.507 (-9)	2.688 (-4)							
8000	7.663 (-1)	1.995 (-1)	9.309 (-3)	2.684 (-2)	1.998 (-7)	3.315 (-3)							
9000	7.508 (-1)	1.761 (-1)	9.246 (-3)	4.714 (-2)	5.100 (-6)	1.678 (-2)							
10.000	7.390 (-1)	1.490 (-1)	9.107 (-3)	6.533 (-2)	4.421 (-5)	4.655 (-2)							
11.000	7.067 (-1)	1.164 (-1)	8.901 (-3)	7.730 (-2)	2.091 (-4)	9.042 (-2)							
12.000	6.835 (-1)	8.239 (-2)	8.655 (-3)	8.195 (-2)	7.302 (-4)	1.428 (-1)							
13.000	6.625 (-1)	5.091 (-2)	8.396 (-3)	7.906 (-2)	2.237 (-3)	1.969 (-1)							
14.000	6.448 (-1)	2.650 (-2)	8.153 (-3)	6.941 (-2)	5.602 (-3)	2.445 (-1)	2.011 (-5)	1.909 (-9)	7.799 (-8)	2.199 (-5)	1.740 (-10)	1.061 (-8)	1.984 (-6)
15.000	6.283 (-1)	1.225 (-2)	7.949 (-3)	5.657 (-2)	1.828 (-2)	2.768 (-1)	5.318 (-5)	2.391 (-8)	2.012 (-7)	5.673 (-5)	4.712 (-9)	9.604 (-8)	3.877 (-6)
16.000	6.068 (-1)	6.002 (-3)	7.768 (-3)	4.559 (-2)	4.175 (-2)	2.918 (-1)	1.162 (-4)	1.929 (-7)	4.109 (-7)	1.213 (-4)	7.114 (-8)	5.694 (-7)	6.396 (-6)
17.000	5.780 (-1)	3.020 (-3)	7.584 (-3)	3.780 (-2)	7.630 (-2)	2.964 (-1)	2.071 (-4)	9.160 (-7)	6.849 (-7)	2.118 (-4)	5.381 (-7)	2.123 (-6)	8.956 (-6)
18.000	5.435 (-1)	2.211 (-3)	7.391 (-3)	3.223 (-2)	1.184 (-1)	2.956 (-1)	3.199 (-4)	2.910 (-6)	9.961 (-7)	3.194 (-4)	2.446 (-6)	5.672 (-6)	1.157 (-5)
19.000	5.053 (-1)	1.556 (-3)	7.189 (-3)	2.798 (-2)	1.651 (-1)	2.919 (-1)	4.510 (-4)	7.110 (-6)	1.327 (-6)	4.366 (-4)	7.954 (-6)	1.219 (-5)	1.417 (-5)
20.000	4.650 (-1)	1.158 (-3)	6.982 (-3)	2.456 (-2)	2.144 (-1)	2.867 (-1)	6.006 (-4)	1.452 (-5)	1.666 (-6)	5.579 (-4)	2.069 (-5)	2.269 (-5)	1.679 (-5)
21.000	4.236 (-1)	8.950 (-4)	6.773 (-3)	2.167 (-2)	2.649 (-1)	2.806 (-1)	7.713 (-4)	2.610 (-5)	2.004 (-6)	6.783 (-4)	4.608 (-5)	3.821 (-5)	1.945 (-5)
22.000	3.820 (-1)	7.100 (-4)	6.566 (-3)	1.916 (-2)	3.155 (-1)	2.740 (-1)	9.679 (-4)	4.263 (-5)	2.334 (-6)	7.938 (-4)	9.165 (-5)	5.985 (-5)	2.231 (-5)
23.000	3.408 (-1)	5.736 (-4)	6.361 (-3)	1.693 (-2)	3.658 (-1)	2.671 (-1)	1.198 (-3)	6.463 (-5)	2.647 (-6)	9.001 (-4)	1.674 (-4)	8.880 (-5)	2.587 (-5)
24.000	3.003 (-1)	4.882 (-4)	6.160 (-3)	1.491 (-2)	4.150 (-1)	2.602 (-1)	1.473 (-3)	9.223 (-5)	2.940 (-6)	9.980 (-4)	2.864 (-4)	1.265 (-4)	2.876 (-5)
25.000	2.608 (-1)	3.871 (-4)	5.966 (-3)	1.307 (-2)	4.627 (-1)	2.533 (-1)	1.809 (-3)	1.251 (-4)	3.209 (-6)	1.072 (-3)	4.658 (-4)	1.747 (-4)	3.259 (-5)
26.000	2.228 (-1)	3.209 (-4)	5.777 (-3)	1.136 (-2)	5.085 (-1)	2.465 (-1)	2.226 (-3)	1.625 (-4)	3.453 (-6)	1.133 (-3)	7.285 (-4)	2.356 (-4)	3.702 (-5)

Altitude: 60,000 Feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000	7.809 (-1)	2.098 (-1)	9.324 (-3)			5.878 (-32)							
3000	7.809 (-1)	2.098 (-1)	9.324 (-3)			1.496 (-19)							
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)	9.318 (-6)	2.205 (-25)	1.580 (-12)							
5000	7.807 (-1)	2.096 (-1)	9.324 (-3)	3.046 (-4)	1.668 (-17)	2.131 (-8)							
6000	7.796 (-1)	2.085 (-1)	9.324 (-3)	2.643 (-3)	1.281 (-12)	7.632 (-6)							
7000	7.754 (-1)	2.043 (-1)	9.322 (-3)	1.066 (-2)	1.903 (-9)	3.402 (-4)							
8000	7.661 (-1)	1.951 (-1)	9.305 (-3)	2.640 (-2)	2.434 (-7)	4.115 (-3)							
9000	7.501 (-1)	1.788 (-1)	9.231 (-3)	4.593 (-2)	5.756 (-6)	1.994 (-2)							
10,000	7.289 (-1)	1.565 (-1)	9.077 (-3)	6.252 (-2)	4.645 (-5)	5.301 (-2)							
11,000	7.053 (-1)	1.329 (-1)	8.857 (-3)	7.286 (-2)	2.100 (-4)	9.986 (-2)							
12,000	6.819 (-1)	7.821 (-2)	8.601 (-3)	7.617 (-2)	7.193 (-4)	1.544 (-1)							
13,000	6.609 (-1)	4.652 (-2)	8.335 (-3)	7.222 (-2)	2.220 (-3)	2.098 (-1)							
14,000	6.426 (-1)	2.269 (-2)	8.094 (-3)	6.180 (-2)	6.786 (-3)	2.570 (-1)	1.967 (-5)	1.562 (-9)	6.413 (-8)	2.099 (-5)	1.543 (-10)	1.000 (-8)	1.381 (-6)
15,000	6.270 (-1)	9.783 (-3)	7.896 (-3)	4.901 (-2)	1.951 (-2)	2.867 (-1)	5.319 (-5)	2.169 (-8)	1.665 (-7)	5.556 (-5)	4.775 (-9)	9.748 (-8)	2.722 (-6)
16,000	6.045 (-1)	4.639 (-3)	7.719 (-3)	3.890 (-2)	4.493 (-2)	2.991 (-1)	1.158 (-4)	1.802 (-7)	3.374 (-7)	1.190 (-4)	7.490 (-8)	5.875 (-7)	4.380 (-6)
17,000	5.743 (-1)	2.622 (-3)	7.536 (-3)	3.205 (-2)	8.145 (-2)	3.016 (-1)	2.037 (-4)	8.424 (-7)	5.554 (-7)	2.057 (-4)	5.579 (-7)	2.161 (-6)	6.103 (-6)
18,000	5.385 (-1)	1.694 (-3)	7.342 (-3)	2.725 (-2)	1.252 (-1)	2.994 (-1)	3.104 (-4)	2.633 (-6)	7.999 (-7)	3.066 (-4)	2.480 (-6)	5.678 (-6)	7.802 (-6)
19,000	4.983 (-1)	1.192 (-3)	7.136 (-3)	2.361 (-2)	1.731 (-1)	2.948 (-1)	4.331 (-4)	6.339 (-6)	1.059 (-6)	4.152 (-4)	7.927 (-6)	1.206 (-5)	9.480 (-6)
20,000	4.582 (-1)	8.870 (-4)	6.931 (-3)	2.068 (-2)	2.233 (-1)	2.889 (-1)	5.720 (-4)	1.281 (-5)	1.323 (-5)	5.264 (-4)	2.039 (-5)	2.227 (-5)	1.116 (-5)
21,000	4.161 (-1)	6.849 (-4)	6.721 (-3)	1.821 (-2)	2.745 (-1)	2.822 (-1)	7.299 (-4)	2.286 (-5)	1.587 (-5)	6.359 (-4)	4.507 (-5)	3.733 (-5)	1.289 (-5)
22,000	3.741 (-1)	5.424 (-4)	6.513 (-3)	1.606 (-2)	3.258 (-1)	2.751 (-1)	9.117 (-4)	3.715 (-5)	1.843 (-5)	7.398 (-4)	8.928 (-5)	5.882 (-5)	1.472 (-5)
23,000	3.328 (-1)	4.372 (-4)	6.308 (-3)	1.414 (-2)	3.766 (-1)	2.679 (-1)	1.125 (-3)	5.612 (-5)	2.087 (-6)	8.344 (-4)	1.628 (-4)	8.646 (-5)	1.670 (-5)
24,000	2.915 (-1)	3.566 (-4)	6.107 (-3)	1.242 (-2)	4.262 (-1)	2.606 (-1)	1.381 (-3)	7.957 (-5)	2.313 (-6)	9.162 (-4)	2.787 (-4)	1.232 (-4)	1.891 (-5)
25,000	2.518 (-1)	2.931 (-4)	5.913 (-3)	1.083 (-2)	4.742 (-1)	2.535 (-1)	1.696 (-3)	1.081 (-4)	2.519 (-6)	9.826 (-4)	4.540 (-4)	1.703 (-4)	2.144 (-5)
26,000	2.136 (-1)	2.418 (-4)	5.725 (-3)	9.375 (-3)	5.203 (-1)	2.465 (-1)	2.063 (-3)	1.402 (-4)	2.704 (-6)	1.031 (-3)	7.124 (-4)	2.306 (-4)	2.438 (-5)

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

Altitude: 70,000 feet

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000	7.809 (-1)	2.098 (-1)	9.324 (-3)			7.463 (-32)							
3000	7.809 (-1)	2.098 (-1)	9.324 (-3)			1.899 (-19)							
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)			2.008 (-12)							
5000	7.809 (-1)	2.098 (-1)	9.324 (-3)			2.748 (-8)							
6000	7.796 (-1)	2.085 (-1)	9.324 (-3)			9.689 (-6)							
7000	7.754 (-1)	2.042 (-1)	9.322 (-3)			4.303 (-4)							
8000	7.658 (-1)	1.937 (-1)	9.300 (-3)			5.081 (-3)							
9000	7.494 (-1)	1.733 (-1)	9.215 (-3)	4.459 (-2)	6.391 (-6)	2.348 (-2)							
10,000	7.277 (-1)	1.438 (-1)	9.045 (-3)	5.960 (-2)	4.800 (-5)	5.979 (-2)							
11,000	7.037 (-1)	1.094 (-1)	8.813 (-3)	6.846 (-2)	2.081 (-4)	1.094 (-1)							
12,000	6.802 (-1)	7.404 (-2)	8.547 (-3)	7.057 (-2)	7.017 (-4)	1.660 (-1)							
13,000	6.593 (-1)	4.223 (-2)	8.277 (-3)	6.570 (-2)	2.193 (-3)	2.223 (-1)							
14,000	6.428 (-1)	1.915 (-2)	8.038 (-3)	5.868 (-2)	6.997 (-3)	2.657 (-1)	1.918 (-5)	1.297 (-9)	5.257 (-8)	2.010 (-5)	1.390 (-10)	9.495 (-9)	9.765 (-7)
15,000	6.257 (-1)	7.693 (-3)	7.848 (-3)	4.216 (-2)	2.094 (-2)	2.956 (-1)	5.304 (-5)	2.003 (-8)	1.375 (-7)	5.467 (-5)	4.942 (-9)	9.993 (-8)	1.893 (-6)
16,000	6.020 (-1)	3.553 (-3)	7.675 (-3)	3.303 (-2)	4.838 (-2)	3.051 (-1)	1.150 (-4)	1.692 (-7)	2.759 (-7)	1.169 (-4)	7.933 (-8)	6.968 (-7)	3.002 (-6)
17,000	5.704 (-1)	2.001 (-3)	7.492 (-3)	2.710 (-2)	8.678 (-2)	3.058 (-1)	1.994 (-4)	7.757 (-7)	4.484 (-7)	1.995 (-4)	5.769 (-7)	2.190 (-6)	9.128 (-6)
18,000	5.334 (-1)	1.294 (-3)	7.296 (-3)	2.299 (-2)	1.319 (-1)	3.024 (-1)	3.000 (-4)	2.374 (-6)	6.397 (-7)	2.940 (-4)	2.501 (-6)	5.656 (-6)	5.227 (-6)
19,000	4.933 (-1)	9.119 (-4)	7.092 (-3)	1.989 (-2)	1.810 (-1)	2.970 (-1)	4.143 (-4)	5.628 (-6)	6.412 (-7)	3.944 (-4)	7.851 (-6)	1.187 (-5)	6.387 (-6)
20,000	4.514 (-1)	6.787 (-4)	6.883 (-3)	1.739 (-2)	2.321 (-1)	2.905 (-1)	5.430 (-4)	1.125 (-5)	1.047 (-6)	4.964 (-4)	1.995 (-5)	2.174 (-5)	7.388 (-6)
21,000	4.089 (-1)	5.238 (-4)	6.673 (-3)	1.529 (-2)	2.840 (-1)	2.833 (-1)	6.687 (-4)	1.993 (-5)	1.252 (-6)	5.960 (-4)	4.378 (-5)	3.627 (-5)	8.501 (-6)
22,000	3.663 (-1)	4.143 (-4)	6.464 (-3)	1.345 (-2)	3.358 (-1)	2.758 (-1)	8.565 (-4)	3.223 (-5)	1.451 (-6)	6.896 (-4)	8.639 (-5)	5.653 (-5)	9.676 (-6)
23,000	3.262 (-1)	3.332 (-4)	6.258 (-3)	1.181 (-2)	3.869 (-1)	2.683 (-1)	1.054 (-3)	4.852 (-5)	1.641 (-6)	7.737 (-4)	1.573 (-4)	8.376 (-5)	1.096 (-5)
24,000	2.831 (-1)	2.711 (-4)	6.058 (-3)	1.034 (-2)	4.369 (-1)	2.607 (-1)	1.292 (-3)	6.887 (-5)	1.816 (-6)	8.451 (-4)	2.694 (-4)	1.194 (-4)	1.280 (-5)
25,000	2.432 (-1)	2.220 (-4)	5.863 (-3)	8.981 (-3)	4.852 (-1)	2.533 (-1)	1.587 (-3)	8.303 (-5)	1.974 (-6)	9.012 (-4)	4.399 (-4)	1.654 (-4)	1.486 (-5)
26,000	2.048 (-1)	1.823 (-4)	5.676 (-3)	7.730 (-3)	5.316 (-1)	2.461 (-1)	1.968 (-3)	1.204 (-4)	2.115 (-6)	9.399 (-4)	6.927 (-4)	2.246 (-4)	1.602 (-5)

Altitude:80,000 feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

	MOLE FRACTION CONCENTRATIONS												
V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000	7.800 (-1)	2.096 (-1)	9.324 (-3)			9.475 (-32)							
3000	7.800 (-1)	2.096 (-1)	9.324 (-3)			2.411 (-19)							
4000	7.800 (-1)	2.096 (-1)	9.324 (-3)	9.818 (-6)	3.555 (-25)	2.566 (-12)							
5000	7.807 (-1)	2.096 (-1)	9.324 (-3)	3.046 (-4)	2.688 (-17)	3.436 (-8)							
6000	7.796 (-1)	2.085 (-1)	9.324 (-3)	2.683 (-3)	2.063 (-12)	1.230 (-5)							
7000	7.754 (-1)	2.042 (-1)	9.321 (-3)	1.062 (-2)	3.017 (-9)	5.435 (-4)							
8000	7.654 (-1)	1.931 (-1)	9.285 (-3)	2.578 (-2)	3.511 (-7)	6.236 (-3)							
9000	7.486 (-1)	1.717 (-1)	9.186 (-3)	4.313 (-2)	6.976 (-6)	2.738 (-2)							
10,000	7.284 (-1)	1.411 (-1)	9.012 (-3)	5.662 (-2)	4.883 (-5)	6.683 (-2)							
11,000	7.022 (-1)	1.057 (-1)	8.768 (-3)	6.412 (-2)	2.037 (-4)	1.190 (-1)							
12,000	6.786 (-1)	6.880 (-2)	8.484 (-3)	6.519 (-2)	6.787 (-4)	1.773 (-1)							
13,000	6.577 (-1)	3.807 (-2)	8.222 (-3)	5.952 (-2)	2.159 (-3)	2.343 (-1)							
14,000	6.412 (-1)	1.582 (-2)	7.987 (-3)	4.885 (-2)	7.252 (-3)	2.795 (-1)	1.872 (-5)	1.095 (-9)	4.302 (-8)	1.934 (-5)	1.280 (-10)	9.105 (-9)	6.773 (-7)
15,000	6.293 (-1)	5.961 (-3)	7.805 (-3)	3.883 (-2)	2.257 (-2)	3.032 (-1)	5.294 (-5)	1.880 (-8)	1.134 (-7)	5.401 (-5)	5.220 (-9)	1.634 (-7)	1.307 (-6)
16,000	6.203 (-1)	2.701 (-3)	7.634 (-3)	2.783 (-2)	5.208 (-2)	3.101 (-1)	1.139 (-4)	1.594 (-7)	2.248 (-7)	1.188 (-4)	8.427 (-8)	6.265 (-7)	2.042 (-6)
17,000	6.663 (-1)	1.522 (-3)	7.451 (-3)	2.286 (-2)	9.226 (-2)	3.092 (-1)	1.948 (-4)	7.125 (-7)	3.605 (-7)	1.933 (-4)	5.941 (-7)	2.211 (-6)	2.774 (-6)
18,000	5.283 (-1)	9.872 (-4)	7.253 (-3)	1.937 (-2)	1.388 (-1)	3.048 (-1)	2.887 (-4)	2.133 (-6)	5.096 (-7)	2.815 (-4)	2.507 (-6)	5.604 (-6)	3.484 (-6)
19,000	5.873 (-1)	6.370 (-4)	7.048 (-3)	1.674 (-2)	1.888 (-1)	2.986 (-1)	3.950 (-4)	4.975 (-6)	6.660 (-7)	3.782 (-4)	7.723 (-6)	1.161 (-5)	4.178 (-6)
20,000	4.948 (-1)	5.182 (-4)	6.838 (-3)	1.462 (-2)	2.406 (-1)	2.916 (-1)	5.139 (-4)	9.837 (-6)	8.257 (-7)	4.676 (-4)	1.939 (-5)	2.151 (-5)	4.872 (-6)
21,000	4.817 (-1)	4.006 (-4)	6.627 (-3)	1.283 (-2)	2.931 (-1)	2.840 (-1)	6.482 (-4)	1.730 (-5)	9.849 (-7)	5.582 (-4)	4.225 (-5)	3.506 (-5)	5.585 (-6)
22,000	3.586 (-1)	3.166 (-4)	6.418 (-3)	1.126 (-2)	3.454 (-1)	2.762 (-1)	8.029 (-4)	2.763 (-5)	1.140 (-5)	6.427 (-4)	8.304 (-5)	5.453 (-5)	6.381 (-6)
23,000	3.164 (-1)	2.582 (-4)	6.212 (-3)	9.866 (-3)	3.969 (-1)	2.684 (-1)	9.853 (-4)	4.176 (-5)	1.287 (-5)	7.176 (-4)	1.510 (-4)	8.076 (-5)	7.168 (-6)
24,000	2.750 (-1)	2.062 (-4)	6.011 (-3)	8.603 (-3)	4.472 (-1)	2.606 (-1)	1.207 (-3)	5.914 (-5)	1.423 (-5)	7.800 (-4)	2.588 (-4)	1.153 (-4)	8.108 (-6)
25,000	2.348 (-1)	1.633 (-4)	5.817 (-3)	7.445 (-3)	4.857 (-1)	2.530 (-1)	1.483 (-3)	7.973 (-5)	1.545 (-5)	8.274 (-4)	4.236 (-4)	1.800 (-4)	9.192 (-6)
26,000	1.963 (-1)	1.276 (-4)	5.630 (-3)	6.376 (-3)	5.422 (-1)	2.456 (-1)	1.839 (-3)	1.030 (-4)	1.653 (-5)	8.576 (-4)	6.698 (-4)	2.680 (-4)	6.185 (-5)

Altitude: 90.000 feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000	7.809 (-1)	2.088 (-1)	9.324 (-3)			8.093 (-31)							
3000	7.809 (-1)	2.088 (-1)	9.324 (-3)			5.091 (-19)							
4000	7.809 (-1)	2.088 (-1)	9.324 (-3)	1.009 (-5)	6.931 (-25)	4.082 (-12)							
5000	7.807 (-1)	2.096 (-1)	9.324 (-3)	3.167 (-4)	4.241 (-17)	4.924 (-8)							
6000	7.795 (-1)	2.084 (-1)	9.329 (-3)	2.698 (-3)	2.959 (-12)	1.675 (-5)							
7000	7.752 (-1)	2.040 (-1)	9.321 (-3)	1.072 (-2)	4.077 (-9)	7.173 (-4)							
8000	7.651 (-1)	1.923 (-1)	9.288 (-3)	2.552 (-2)	4.326 (-7)	7.821 (-3)							
9000	7.475 (-1)	1.695 (-1)	9.174 (-3)	4.159 (-2)	7.651 (-6)	3.215 (-2)							
10.000	7.249 (-1)	1.378 (-1)	8.975 (-3)	5.350 (-2)	4.951 (-5)	7.485 (-2)							
11.000	7.003 (-1)	1.016 (-1)	8.720 (-3)	5.967 (-2)	1.983 (-4)	1.294 (-1)							
12.000	6.765 (-1)	6.537 (-2)	8.439 (-3)	5.975 (-2)	6.544 (-4)	1.693 (-1)							
13.000	6.560 (-1)	3.368 (-2)	8.164 (-3)	5.334 (-2)	2.135 (-3)	2.467 (-1)							
14.000	6.401 (-1)	1.279 (-2)	7.936 (-3)	4.153 (-2)	7.639 (-3)	2.900 (-1)	1.838 (-5)	9.548 (-10)	3.500 (-8)	1.879 (-5)	1.234 (-10)	8.970 (-9)	4.589 (-7)
15.000	6.226 (-1)	4.470 (-3)	7.763 (-3)	3.029 (-2)	2.467 (-2)	3.101 (-1)	5.310 (-5)	1.810 (-8)	9.265 (-8)	5.375 (-5)	5.731 (-9)	1.094 (-7)	8.808 (-7)
16.000	6.961 (-1)	2.005 (-3)	7.595 (-3)	2.331 (-2)	5.642 (-2)	3.143 (-1)	1.126 (-4)	1.511 (-7)	1.807 (-7)	1.129 (-4)	9.078 (-8)	6.509 (-7)	1.358 (-6)
17.000	5.617 (-1)	1.136 (-3)	7.410 (-3)	1.906 (-2)	9.836 (-2)	3.119 (-1)	1.889 (-4)	6.524 (-7)	2.856 (-7)	1.869 (-4)	6.134 (-7)	2.230 (-6)	1.815 (-6)
18.000	5.226 (-1)	7.401 (-4)	7.211 (-3)	1.614 (-2)	1.461 (-1)	3.066 (-1)	2.768 (-4)	1.902 (-6)	3.997 (-7)	2.687 (-4)	2.507 (-6)	5.535 (-6)	2.262 (-6)
19.000	4.809 (-1)	5.242 (-4)	7.004 (-3)	1.394 (-2)	1.971 (-1)	2.998 (-1)	3.749 (-4)	4.358 (-6)	5.192 (-7)	3.539 (-4)	7.554 (-6)	1.181 (-5)	2.697 (-6)
20.000	4.378 (-1)	3.911 (-4)	6.793 (-3)	1.216 (-2)	2.496 (-1)	2.923 (-1)	4.842 (-4)	8.515 (-6)	6.412 (-7)	4.390 (-4)	1.874 (-5)	2.039 (-5)	3.131 (-6)
21.000	3.943 (-1)	3.018 (-4)	6.582 (-3)	1.065 (-2)	3.026 (-1)	2.844 (-1)	6.073 (-4)	1.485 (-5)	7.630 (-7)	5.210 (-4)	4.050 (-5)	3.370 (-5)	3.577 (-6)
22.000	3.510 (-1)	2.383 (-4)	6.372 (-3)	9.334 (-3)	3.553 (-1)	2.763 (-1)	7.490 (-4)	2.377 (-5)	8.617 (-7)	5.968 (-4)	7.926 (-5)	5.230 (-5)	4.051 (-6)
23.000	3.083 (-1)	1.910 (-4)	6.166 (-3)	8.156 (-3)	4.072 (-1)	2.682 (-1)	9.167 (-4)	3.553 (-5)	9.944 (-7)	6.633 (-4)	1.439 (-4)	7.743 (-5)	4.571 (-6)
24.000	2.657 (-1)	1.546 (-4)	5.965 (-3)	7.089 (-3)	4.577 (-1)	2.602 (-1)	1.121 (-3)	5.019 (-5)	1.098 (-6)	7.176 (-4)	2.468 (-4)	1.106 (-4)	5.168 (-6)
25.000	2.264 (-1)	1.257 (-4)	5.771 (-3)	6.108 (-3)	5.065 (-1)	2.524 (-1)	1.379 (-3)	6.754 (-5)	1.192 (-6)	7.570 (-4)	4.051 (-4)	1.540 (-4)	5.862 (-6)
26.000	1.877 (-1)	1.023 (-4)	5.584 (-3)	5.200 (-3)	5.531 (-1)	2.449 (-1)	1.715 (-3)	8.706 (-5)	1.273 (-6)	7.798 (-4)	6.435 (-4)	2.106 (-4)	6.711 (-6)

Altitude: 100,000 feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000	7.889 (-1)	2.088 (-1)	9.324 (-3)			2.401 (-30)							
3000	7.889 (-1)	2.088 (-1)	9.324 (-3)			1.225 (-18)							
4000	7.889 (-1)	2.088 (-1)	9.324 (-3)	1.117 (-5)	1.514 (-24)	6.931 (-12)							
5000	7.887 (-1)	2.086 (-1)	9.324 (-3)	3.330 (-4)	7.067 (-17)	7.246 (-8)							
6000	7.795 (-1)	2.084 (-1)	9.324 (-3)	2.770 (-3)	4.360 (-12)	2.310 (-5)							
7000	7.751 (-1)	2.038 (-1)	9.320 (-3)	1.085 (-2)	5.562 (-9)	9.488 (-4)							
8000	7.695 (-1)	1.913 (-1)	9.279 (-3)	2.523 (-2)	5.277 (-7)	9.729 (-3)							
9000	7.468 (-1)	1.672 (-1)	9.150 (-3)	4.000 (-2)	8.260 (-6)	3.732 (-2)							
10,000	7.232 (-1)	1.343 (-1)	8.937 (-3)	5.045 (-2)	4.958 (-5)	8.302 (-2)							
11,000	6.884 (-1)	9.753 (-2)	8.672 (-3)	5.545 (-2)	1.916 (-4)	1.397 (-1)							
12,000	6.796 (-1)	6.093 (-2)	8.385 (-3)	5.468 (-2)	6.285 (-4)	2.008 (-1)							
13,000	6.543 (-1)	2.853 (-2)	8.110 (-3)	4.764 (-2)	2.118 (-3)	2.583 (-1)							
14,000	6.389 (-1)	1.010 (-2)	7.891 (-3)	3.568 (-2)	8.139 (-3)	2.992 (-1)	1.818 (-5)	8.640 (-10)	2.866 (-8)	1.845 (-5)	1.244 (-10)	9.058 (-9)	3.134 (-7)
15,000	6.208 (-1)	3.324 (-3)	7.726 (-3)	2.539 (-2)	2.706 (-2)	3.156 (-1)	5.333 (-5)	1.774 (-8)	7.592 (-8)	5.371 (-5)	6.412 (-9)	1.168 (-7)	5.962 (-7)
16,000	5.827 (-1)	1.690 (-3)	7.558 (-3)	1.946 (-2)	6.096 (-2)	3.176 (-1)	1.110 (-4)	1.434 (-7)	1.454 (-7)	1.109 (-4)	9.767 (-8)	6.745 (-7)	8.992 (-7)
17,000	5.571 (-1)	8.504 (-4)	7.372 (-3)	1.592 (-2)	1.045 (-1)	3.139 (-1)	1.830 (-4)	5.964 (-7)	2.264 (-7)	1.805 (-4)	6.298 (-7)	2.238 (-6)	1.184 (-6)
18,000	5.370 (-1)	5.576 (-4)	7.171 (-3)	1.249 (-2)	1.534 (-1)	3.078 (-1)	2.648 (-4)	1.693 (-6)	3.140 (-7)	2.564 (-4)	2.492 (-6)	5.844 (-6)	1.475 (-6)
19,000	5.196 (-1)	3.964 (-4)	6.963 (-3)	1.165 (-2)	2.052 (-1)	3.006 (-1)	3.554 (-4)	3.812 (-6)	4.056 (-7)	3.346 (-4)	7.364 (-6)	1.087 (-6)	1.750 (-6)
20,000	5.310 (-1)	2.963 (-4)	6.751 (-3)	1.015 (-2)	2.582 (-1)	2.926 (-1)	4.558 (-4)	7.360 (-6)	4.991 (-7)	4.124 (-4)	1.800 (-5)	1.862 (-5)	2.028 (-6)
21,000	5.071 (-1)	2.288 (-4)	6.539 (-3)	8.878 (-3)	3.117 (-1)	2.844 (-1)	5.657 (-4)	1.274 (-5)	5.926 (-7)	4.868 (-4)	3.861 (-5)	3.227 (-5)	2.306 (-6)
22,000	3.435 (-1)	1.806 (-4)	6.329 (-3)	7.765 (-3)	3.647 (-1)	2.761 (-1)	6.867 (-4)	2.028 (-5)	6.840 (-7)	5.551 (-4)	7.526 (-5)	4.898 (-5)	2.605 (-6)
23,000	3.006 (-1)	1.445 (-4)	6.123 (-3)	6.769 (-3)	4.168 (-1)	2.678 (-1)	8.529 (-4)	3.021 (-5)	7.709 (-7)	6.144 (-4)	1.365 (-4)	7.389 (-6)	2.885 (-6)
24,000	2.588 (-1)	1.167 (-4)	5.922 (-3)	5.864 (-3)	4.676 (-1)	2.596 (-1)	1.062 (-3)	4.258 (-5)	8.512 (-7)	6.617 (-4)	2.363 (-4)	1.059 (-5)	3.384 (-6)
25,000	2.184 (-1)	9.460 (-5)	5.728 (-3)	5.032 (-3)	5.165 (-1)	2.517 (-1)	1.282 (-3)	5.719 (-5)	9.229 (-7)	6.947 (-4)	3.856 (-4)	1.478 (-4)	3.764 (-6)
26,000	1.796 (-1)	7.665 (-5)	5.542 (-3)	4.260 (-3)	5.632 (-1)	2.440 (-1)	1.600 (-3)	7.359 (-5)	9.851 (-7)	7.114 (-4)	6.156 (-4)	2.030 (-4)	4.318 (-6)

Altitude: 110,000 feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

	MOLE FRACTION CONCENTRATIONS												
V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000	7.809 (-1)	2.098 (-1)	9.324 (-3)			1.309 (-29)							
3500	7.809 (-1)	2.098 (-1)	9.324 (-3)			2.872 (-18)							
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)	1.234 (-5)	3.243 (-24)	1.160 (-11)							
5000	7.807 (-1)	2.096 (-1)	9.324 (-3)	3.499 (-4)	1.163 (-16)	1.054 (-7)							
6000	7.794 (-1)	2.084 (-1)	9.324 (-3)	2.844 (-3)	6.353 (-12)	3.152 (-5)							
7000	7.749 (-1)	2.036 (-1)	9.318 (-3)	1.096 (-2)	7.676 (-9)	1.240 (-3)							
8000	7.638 (-1)	1.902 (-1)	9.269 (-3)	2.486 (-2)	6.285 (-7)	1.189 (-2)							
9000	7.450 (-1)	1.648 (-1)	9.125 (-3)	3.838 (-2)	8.736 (-6)	4.264 (-2)							
10,000	7.215 (-1)	1.310 (-1)	8.899 (-3)	4.753 (-2)	4.899 (-5)	8.101 (-2)							
11,000	6.966 (-1)	9.356 (-2)	8.626 (-3)	5.154 (-2)	1.836 (-4)	1.495 (-2)							
12,000	6.727 (-1)	5.673 (-2)	8.335 (-3)	5.006 (-2)	6.015 (-4)	2.116 (-1)							
13,000	6.528 (-1)	2.572 (-2)	8.061 (-3)	4.252 (-2)	2.108 (-3)	2.688 (-1)							
14,000	6.379 (-1)	7.878 (-3)	7.852 (-3)	3.058 (-2)	6.747 (-3)	3.070 (-1)	1.810 (-5)	8.093 (-10)	2.370 (-4)	1.828 (-5)	1.304 (-10)	9.340 (-9)	2.160 (-7)
15,000	6.188 (-1)	2.478 (-2)	7.694 (-3)	2.134 (-2)	2.964 (-2)	3.199 (-1)	5.353 (-5)	1.753 (-8)	6.253 (-3)	5.373 (-5)	7.213 (-9)	1.248 (-7)	4.051 (-7)
16,000	5.893 (-1)	1.117 (-2)	7.526 (-3)	1.634 (-2)	6.553 (-2)	3.199 (-1)	1.082 (-4)	1.359 (-7)	1.175 (-2)	1.088 (-4)	1.043 (-7)	6.947 (-7)	6.041 (-7)
17,000	5.525 (-1)	6.438 (-3)	7.337 (-3)	1.338 (-2)	1.105 (-1)	3.153 (-1)	1.770 (-4)	5.441 (-7)	1.805 (-2)	1.742 (-4)	6.411 (-7)	2.285 (-6)	7.940 (-7)
18,000	5.116 (-1)	4.248 (-3)	7.135 (-3)	1.154 (-2)	1.603 (-1)	3.086 (-1)	2.532 (-4)	1.506 (-6)	2.482 (-2)	2.446 (-4)	2.460 (-6)	5.322 (-6)	9.754 (-7)
19,000	4.686 (-1)	3.032 (-3)	6.926 (-3)	9.793 (-3)	2.127 (-1)	3.009 (-1)	3.369 (-4)	3.335 (-6)	3.189 (-2)	3.167 (-4)	7.128 (-6)	1.060 (-5)	1.152 (-6)
20,000	4.246 (-1)	2.271 (-3)	6.716 (-3)	8.529 (-3)	2.663 (-1)	2.927 (-1)	4.294 (-4)	6.369 (-6)	3.913 (-2)	3.879 (-4)	1.721 (-5)	1.881 (-5)	1.328 (-6)
21,000	3.804 (-1)	1.755 (-3)	6.501 (-3)	7.452 (-3)	3.201 (-1)	2.843 (-1)	5.332 (-4)	1.094 (-5)	4.637 (-2)	4.558 (-4)	3.665 (-5)	3.081 (-5)	1.508 (-6)
22,000	3.366 (-1)	1.384 (-3)	6.291 (-3)	6.507 (-3)	3.734 (-1)	2.757 (-1)	6.527 (-4)	1.734 (-5)	5.348 (-2)	5.177 (-4)	7.117 (-5)	4.764 (-5)	1.701 (-6)
23,000	2.935 (-1)	1.107 (-3)	6.085 (-3)	5.660 (-3)	4.257 (-1)	2.673 (-1)	7.948 (-4)	2.575 (-5)	6.025 (-2)	5.709 (-4)	1.290 (-4)	7.054 (-5)	1.914 (-6)
24,000	2.516 (-1)	8.817 (-4)	5.884 (-3)	4.889 (-3)	4.766 (-1)	2.590 (-1)	9.700 (-4)	3.621 (-5)	6.651 (-2)	6.126 (-4)	2.216 (-4)	1.011 (-4)	2.159 (-6)
25,000	2.110 (-1)	7.206 (-4)	5.690 (-3)	4.178 (-3)	5.257 (-1)	2.509 (-1)	1.185 (-3)	4.857 (-5)	7.211 (-2)	6.804 (-4)	3.658 (-4)	1.415 (-4)	2.454 (-6)
26,000	1.722 (-1)	5.813 (-4)	5.504 (-3)	3.517 (-3)	5.725 (-1)	2.432 (-1)	1.445 (-3)	6.241 (-5)	7.693 (-2)	6.523 (-4)	5.870 (-4)	1.953 (-4)	2.822 (-6)

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

Altitude: 120,000 feet

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000	7.809 (-1)	2.098 (-1)	9.324 (-3)			6.649 (-29)							
3000	7.809 (-1)	2.098 (-1)	9.324 (-3)			6.557 (-18)							
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)	1.361 (-5)	6.817 (-24)	1.919 (-11)							
5000	7.807 (-1)	2.096 (-1)	9.324 (-3)	3.673 (-4)	1.888 (-16)	1.518 (-7)							
6000	7.794 (-1)	2.083 (-1)	9.324 (-3)	2.919 (-3)	9.158 (-12)	4.258 (-5)							
7000	7.747 (-1)	2.033 (-1)	9.317 (-3)	1.106 (-2)	9.901 (-9)	1.500 (-3)							
8000	7.631 (-1)	1.889 (-1)	9.257 (-3)	2.442 (-2)	7.318 (-7)	1.430 (-2)							
9000	7.437 (-1)	1.624 (-1)	9.100 (-3)	3.674 (-2)	9.076 (-6)	4.805 (-2)							
10,000	7.159 (-1)	1.277 (-1)	8.863 (-3)	4.476 (-2)	4.788 (-5)	9.878 (-2)							
11,000	6.848 (-1)	8.876 (-2)	8.583 (-3)	4.782 (-2)	1.768 (-4)	1.588 (-1)							
12,000	6.709 (-1)	5.276 (-2)	8.288 (-3)	4.587 (-2)	5.744 (-4)	2.216 (-1)							
13,000	6.514 (-1)	2.224 (-2)	8.017 (-3)	3.792 (-2)	2.108 (-3)	2.783 (-1)							
14,000	6.368 (-1)	6.088 (-3)	7.818 (-3)	2.616 (-2)	9.476 (-3)	3.135 (-1)	1.814 (-5)	7.825 (-10)	1.978 (-8)	1.826 (-5)	1.415 (-10)	9.822 (-9)	1.505 (-7)
15,000	6.158 (-1)	1.856 (-3)	7.666 (-3)	1.799 (-2)	3.238 (-2)	3.232 (-1)	5.368 (-5)	1.741 (-8)	5.174 (-8)	5.375 (-5)	8.118 (-9)	1.332 (-7)	2.790 (-7)
16,000	5.858 (-1)	8.457 (-4)	7.496 (-3)	1.379 (-2)	7.008 (-2)	3.218 (-1)	1.072 (-4)	1.285 (-7)	9.531 (-8)	1.066 (-4)	1.103 (-7)	7.111 (-7)	4.103 (-7)
17,000	5.480 (-1)	4.926 (-4)	7.306 (-3)	1.131 (-2)	1.162 (-1)	3.163 (-1)	1.710 (-4)	4.956 (-7)	1.446 (-7)	1.680 (-4)	6.475 (-7)	2.219 (-6)	5.846 (-7)
18,000	5.069 (-1)	3.272 (-4)	7.102 (-3)	8.599 (-3)	1.669 (-1)	3.091 (-1)	2.419 (-4)	1.339 (-6)	1.974 (-7)	2.334 (-4)	2.413 (-6)	5.185 (-6)	6.531 (-7)
19,000	4.629 (-1)	2.344 (-4)	6.882 (-3)	6.288 (-3)	2.199 (-1)	3.011 (-1)	3.195 (-4)	2.919 (-6)	2.524 (-7)	3.000 (-4)	6.864 (-6)	1.021 (-5)	7.683 (-7)
20,000	4.184 (-1)	1.759 (-4)	6.679 (-3)	7.214 (-3)	2.739 (-1)	2.926 (-1)	4.048 (-4)	5.519 (-6)	3.089 (-7)	3.655 (-4)	1.639 (-5)	1.799 (-5)	6.830 (-7)
21,000	3.762 (-1)	1.360 (-4)	6.466 (-3)	6.298 (-3)	3.280 (-1)	2.840 (-1)	5.005 (-4)	9.417 (-6)	3.656 (-7)	4.277 (-4)	3.465 (-5)	2.936 (-5)	1.001 (-6)
22,000	3.391 (-1	1.073 (-4)	6.256 (-3)	5.491 (-3)	3.815 (-1)	2.753 (-1)	6.106 (-4)	1.486 (-5)	4.213 (-7)	4.841 (-4)	6.709 (-5)	4.532 (-5)	1.125 (-6)
23,000	2.869 (-1)	8.589 (-5)	6.050 (-3)	4.766 (-3)	4.340 (-1)	2.667 (-1)	7.419 (-4)	2.201 (-5)	4.746 (-7)	5.321 (-4)	1.215 (-4)	6.713 (-5)	1.266 (-6)
24,000	2.448 (-1)	6.881 (-5)	5.849 (-3)	4.105 (-3)	4.850 (-1)	2.583 (-1)	9.045 (-4)	3.089 (-5)	5.240 (-7)	5.692 (-4)	2.090 (-4)	9.639 (-5)	1.428 (-6)
25,000	2.093 (-1)	5.552 (-5)	5.655 (-3)	3.495 (-3)	5.342 (-1)	2.501 (-1)	1.114 (-3)	4.138 (-5)	5.681 (-7)	5.927 (-4)	3.462 (-4)	1.354 (-4)	1.628 (-6)
26,000	1.854 (-1)	4.459 (-5)	5.469 (-3)	2.926 (-3)	5.811 (-1)	2.423 (-1)	1.399 (-3)	5.311 (-5)	6.061 (-7)	6.008 (-4)	5.585 (-4)	1.878 (-4)	1.871 (-6)

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

Altitude: 130,000 feet

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000	7.809 (-1)	2.098 (-1)	9.324 (-3)			3.164 (-28)							
3000	7.809 (-1)	2.098 (-1)	9.324 (-3)			1.461 (-17)							
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)	1.496 (-5)	1.408 (-23)	3.115 (-11)							
5000	7.809 (-1)	2.096 (-1)	9.324 (-3)	3.855 (-4)	3.032 (-16)	2.162 (-7)							
6000	7.794 (-1)	2.083 (-1)	9.374 (-3)	2.995 (-3)	1.307 (-11)	5.699 (-5)							
7000	7.745 (-1)	2.030 (-1)	9.314 (-3)	1.115 (-2)	1.292 (-8)	2.041 (-3)							
8000	7.623 (-1)	1.876 (-1)	9.245 (-3)	2.393 (-2)	8.340 (-7)	1.692 (-2)							
9000	7.424 (-1)	1.599 (-1)	8.075 (-3)	3.513 (-2)	9.287 (-6)	5.350 (-2)							
10,000	7.183 (-1)	1.244 (-1)	6.828 (-3)	4.214 (-2)	6.640 (-5)	1.063 (-1)							
11,000	6.930 (-1)	8.611 (-2)	5.542 (-3)	4.459 (-2)	1.657 (-4)	1.676 (-1)							
12,000	6.692 (-1)	4.901 (-2)	5.245 (-3)	4.206 (-2)	5.481 (-4)	2.309 (-1)							
13,000	6.501 (-1)	1.912 (-2)	7.976 (-3)	3.378 (-2)	2.122 (-3)	2.869 (-1)							
14,000	6.360 (-1)	4.671 (-3)	7.789 (-3)	2.236 (-2)	1.033 (-2)	3.185 (-1)	1.830 (-5)	7.774 (-10)	1.665 (-8)	1.838 (-5)	1.584 (-10)	1.050 (-8)	1.061 (-7)
15,000	6.146 (-1)	1.389 (-3)	7.641 (-3)	1.523 (-2)	3.525 (-2)	3.257 (-1)	5.373 (-5)	1.730 (-8)	4.297 (-8)	5.372 (-5)	8.097 (-9)	1.417 (-7)	1.840 (-7)
16,000	5.824 (-1)	6.468 (-4)	7.469 (-3)	1.170 (-2)	7.458 (-2)	3.231 (-1)	1.050 (-4)	1.212 (-7)	7.767 (-8)	1.042 (-4)	1.157 (-7)	7.234 (-7)	2.817 (-7)
17,000	5.436 (-1)	3.808 (-4)	7.277 (-3)	9.620 (-3)	1.218 (-1)	3.159 (-1)	1.650 (-4)	4.507 (-7)	1.165 (-7)	1.619 (-4)	6.492 (-7)	2.192 (-6)	3.642 (-7)
18,000	5.015 (-1)	2.546 (-4)	7.072 (-3)	8.172 (-3)	1.732 (-1)	3.093 (-1)	2.311 (-4)	1.191 (-6)	1.579 (-7)	2.228 (-4)	2.353 (-6)	5.033 (-6)	4.428 (-7)
19,000	4.578 (-1)	1.830 (-4)	6.861 (-3)	7.057 (-3)	2.267 (-1)	3.010 (-1)	3.030 (-4)	2.558 (-6)	2.011 (-7)	2.844 (-4)	6.582 (-6)	9.803 (-6)	5.194 (-7)
20,000	4.130 (-1)	1.376 (-4)	6.647 (-3)	6.141 (-3)	2.810 (-1)	2.924 (-1)	3.820 (-4)	4.790 (-6)	2.455 (-7)	3.448 (-4)	1.555 (-5)	1.717 (-5)	5.850 (-7)
21,000	3.683 (-1)	1.065 (-4)	6.434 (-3)	5.355 (-3)	3.353 (-1)	2.835 (-1)	4.704 (-4)	8.123 (-6)	2.902 (-7)	4.020 (-4)	3.269 (-5)	2.792 (-5)	6.730 (-7)
22,000	3.241 (-1)	8.402 (-5)	6.224 (-3)	4.663 (-3)	3.890 (-1)	2.747 (-1)	5.722 (-4)	1.276 (-5)	3.343 (-7)	4.537 (-4)	6.308 (-5)	4.306 (-5)	7.562 (-7)
23,000	2.806 (-1)	6.704 (-5)	6.017 (-3)	4.039 (-3)	4.416 (-1)	2.661 (-1)	6.987 (-4)	1.686 (-5)	3.766 (-7)	4.978 (-4)	1.141 (-4)	6.380 (-5)	8.488 (-7)
24,000	2.387 (-1)	5.381 (-5)	5.817 (-3)	3.470 (-3)	4.927 (-1)	2.576 (-1)	8.449 (-4)	2.643 (-5)	4.160 (-7)	5.305 (-4)	1.967 (-4)	9.180 (-5)	9.567 (-7)
25,000	1.980 (-1)	4.324 (-5)	5.623 (-3)	2.943 (-3)	5.420 (-1)	2.493 (-1)	1.042 (-3)	3.536 (-5)	4.512 (-7)	5.507 (-4)	3.269 (-4)	1.294 (-4)	1.088 (-6)
26,000	1.591 (-1)	3.458 (-5)	5.437 (-3)	2.452 (-3)	5.889 (-1)	2.414 (-1)	1.311 (-3)	4.535 (-5)	4.815 (-7)	5.557 (-4)	5.304 (-4)	1.804 (-4)	1.257 (-6)

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

Altitude:140,000 feet

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000	7.809 (-1)	2.098 (-1)	9.324 (-3)			1.418 (-27)							
3000	7.809 (-1)	2.098 (-1)	9.324 (-3)			3.183 (-17)							
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)	1.647 (-5)	2.860 (-23)	5.009 (-11)							
5000	7.807 (-1)	2.096 (-1)	9.324 (-3)	4.042 (-4)	4.815 (-16)	3.052 (-7)							
6000	7.793 (-1)	2.082 (-1)	9.324 (-3)	3.072 (-3)	1.848 (-11)	7.563 (-5)							
7000	7.743 (-1)	2.026 (-1)	9.312 (-3)	1.122 (-2)	1.660 (-8)	2.573 (-3)							
8000	7.615 (-1)	1.862 (-1)	9.232 (-3)	2.338 (-2)	9.319 (-7)	1.975 (-2)							
9000	7.411 (-1)	1.576 (-1)	9.069 (-3)	3.355 (-2)	9.382 (-6)	5.893 (-2)							
10,000	7.167 (-1)	1.213 (-1)	8.795 (-3)	3.968 (-2)	4.464 (-5)	1.135 (-1)							
11,000	6.913 (-1)	8.261 (-2)	8.503 (-3)	4.152 (-2)	1.566 (-4)	1.759 (-1)							
12,000	6.675 (-1)	4.567 (-2)	8.206 (-3)	3.859 (-2)	5.230 (-4)	2.397 (-1)							
13,000	6.489 (-1)	1.628 (-2)	7.940 (-3)	3.005 (-2)	2.151 (-3)	2.947 (-1)							
14,000	6.351 (-1)	3.565 (-3)	7.765 (-3)	1.911 (-2)	1.134 (-2)	3.232 (-1)							
15,000	6.124 (-1)	1.063 (-3)	7.618 (-3)	1.295 (-2)	3.820 (-2)	3.277 (-1)	5.368 (-5)	1.716 (-8)	3.582 (-8)	5.361 (-5)	1.013 (-8)	1.499 (-7)	1.362 (-7)
16,000	5.789 (-1)	4.996 (-4)	7.445 (-3)	9.987 (-3)	7.901 (-2)	3.239 (-1)	1.027 (-4)	1.139 (-7)	6.356 (-8)	1.018 (-6)	1.203 (-7)	7.318 (-7)	1.054 (-7)
17,000	5.384 (-1)	2.573 (-4)	7.250 (-3)	6.227 (-3)	1.272 (-1)	3.173 (-1)	1.591 (-4)	4.093 (-7)	9.431 (-8)	1.560 (-4)	6.467 (-7)	2.157 (-6)	2.509 (-7)
18,000	4.968 (-1)	2.000 (-4)	7.044 (-3)	6.996 (-3)	1.792 (-1)	3.094 (-1)	2.208 (-4)	1.059 (-6)	1.270 (-7)	2.127 (-4)	2.285 (-6)	4.871 (-6)	3.037 (-7)
19,000	4.525 (-1)	1.443 (-4)	6.832 (-3)	6.043 (-3)	2.330 (-1)	3.008 (-1)	2.877 (-4)	2.244 (-6)	1.612 (-7)	2.699 (-4)	6.290 (-6)	9.395 (-6)	3.950 (-7)
20,000	4.076 (-1)	1.087 (-4)	6.618 (-3)	5.257 (-3)	2.876 (-1)	2.920 (-1)	3.609 (-4)	4.165 (-6)	1.964 (-7)	3.259 (-4)	1.472 (-5)	1.636 (-5)	4.860 (-7)
21,000	3.628 (-1)	8.423 (-5)	6.405 (-3)	4.581 (-3)	3.422 (-1)	2.831 (-1)	4.427 (-4)	7.022 (-6)	2.319 (-7)	3.786 (-4)	3.076 (-5)	2.652 (-5)	4.584 (-7)
22,000	3.185 (-1)	6.643 (-5)	6.194 (-3)	3.984 (-3)	3.960 (-1)	2.742 (-1)	5.370 (-4)	1.099 (-5)	2.670 (-7)	4.262 (-4)	5.918 (-5)	4.086 (-5)	6.142 (-7)
23,000	2.751 (-1)	5.296 (-5)	5.988 (-3)	3.445 (-3)	4.457 (-1)	2.654 (-1)	6.497 (-4)	1.620 (-5)	3.010 (-7)	4.661 (-4)	1.071 (-4)	6.059 (-5)	5.765 (-7)
24,000	2.329 (-1)	4.284 (-5)	5.787 (-3)	2.952 (-3)	4.999 (-1)	2.568 (-1)	7.905 (-4)	2.268 (-5)	3.326 (-7)	4.960 (-4)	1.848 (-4)	8.786 (-5)	6.484 (-7)
25,000	1.922 (-1)	3.601 (-5)	5.594 (-3)	2.495 (-3)	5.492 (-1)	2.485 (-1)	9.761 (-4)	3.033 (-5)	3.611 (-7)	5.133 (-4)	3.082 (-4)	1.236 (-4)	7.382 (-7)
26,000	1.533 (-1)	2.709 (-5)	5.408 (-3)	2.068 (-3)	5.962 (-1)	2.406 (-1)	1.231 (-3)	3.887 (-5)	3.855 (-7)	5.160 (-4)	5.029 (-4)	1.732 (-4)	8.551 (-7)

Altitude: 150,000 feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000	7.809 (-1)	2.098 (-1)	9.324 (-3)			5.999 (-27)							
3000	7.809 (-1)	2.098 (-1)	9.324 (-3)			6.783 (-17)							
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)	1.807 (-5)	5.717 (-23)	7.960 (-11)							
5000	7.807 (-1)	2.096 (-1)	9.324 (-3)	4.237 (-4)	7.569 (-16)	4.271 (-7)							
6000	7.788 (-1)	2.092 (-1)	9.324 (-3)	3.149 (-3)	2.588 (-11)	9.954 (-5)							
7000	7.740 (-1)	2.022 (-1)	9.309 (-3)	1.128 (-2)	2.101 (-8)	3.205 (-3)							
8000	7.606 (-1)	1.846 (-1)	9.218 (-3)	2.280 (-2)	1.023 (-6)	2.274 (-2)							
9000	7.398 (-1)	1.569 (-1)	9.024 (-3)	3.201 (-2)	9.373 (-6)	6.451 (-2)							
10,000	7.151 (-1)	1.182 (-1)	8.762 (-3)	3.738 (-2)	4.270 (-5)	1.205 (-1)							
11,000	6.896 (-1)	7.926 (-2)	8.466 (-3)	3.869 (-2)	1.476 (-4)	1.638 (-1)							
12,000	6.660 (-1)	4.212 (-2)	8.166 (-3)	3.544 (-2)	4.995 (-4)	2.478 (-1)							
13,000	6.478 (-1)	1.375 (-2)	7.907 (-3)	2.659 (-2)	2.199 (-3)	3.017 (-1)							
14,000	6.341 (-1)	2.721 (-3)	7.743 (-3)	1.635 (-2)	1.244 (-2)	3.266 (-1)	1.884 (-5)	8.126 (-10)	1.205 (-8)	1.887 (-5)	2.109 (-10)	1.282 (-8)	5.930 (-8)
15,000	6.101 (-1)	8.154 (-4)	7.597 (-3)	1.107 (-2)	4.120 (-2)	3.291 (-1)	5.349 (-5)	1.694 (-8)	2.594 (-8)	5.357 (-5)	1.116 (-8)	1.575 (-7)	9.644 (-8)
16,000	5.756 (-1)	3.897 (-4)	7.422 (-3)	8.566 (-3)	8.332 (-2)	3.245 (-1)	1.002 (-4)	1.066 (-7)	5.522 (-8)	9.931 (-5)	1.239 (-7)	7.357 (-7)	1.369 (-7)
17,000	5.354 (-1)	2.343 (-4)	7.226 (-3)	7.074 (-3)	1.323 (-1)	3.175 (-1)	1.553 (-4)	3.713 (-7)	7.474 (-8)	1.502 (-4)	6.405 (-7)	2.115 (-6)	1.767 (-7)
18,000	4.922 (-1)	1.585 (-4)	7.018 (-3)	6.022 (-3)	1.848 (-1)	3.093 (-1)	2.110 (-4)	9.415 (-7)	1.028 (-7)	2.032 (-4)	2.209 (-6)	4.703 (-6)	2.107 (-7)
19,000	4.477 (-1)	1.148 (-4)	6.806 (-3)	5.204 (-3)	2.391 (-1)	3.006 (-1)	2.733 (-4)	1.971 (-6)	1.300 (-7)	2.564 (-4)	5.983 (-6)	5.988 (-6)	2.456 (-7)
20,000	4.025 (-1)	8.667 (-5)	6.591 (-3)	4.525 (-3)	2.939 (-1)	2.916 (-1)	3.413 (-4)	3.628 (-6)	1.681 (-7)	3.083 (-4)	1.390 (-5)	1.566 (-5)	2.808 (-7)
21,000	3.577 (-1)	6.720 (-5)	6.378 (-3)	3.941 (-3)	3.486 (-1)	2.825 (-1)	4.172 (-4)	6.084 (-6)	1.965 (-7)	3.572 (-4)	2.889 (-5)	2.517 (-5)	3.166 (-7)
22,000	3.133 (-1)	5.299 (-5)	6.167 (-3)	3.423 (-3)	4.025 (-1)	2.736 (-1)	5.047 (-4)	9.492 (-6)	2. 48 (-7)	4.012 (-4)	5.545 (-5)	3.874 (-5)	3.538 (-7)
23,000	2.698 (-1)	4.221 (-5)	5.961 (-3)	2.955 (-3)	4.553 (-1)	2.647 (-1)	6.095 (-4)	1.396 (-5)	2.121 (-7)	4.379 (-4)	1.003 (-4)	5.750 (-5)	3.868 (-7)
24,000	2.275 (-1)	3.377 (-5)	5.760 (-3)	2.525 (-3)	5.066 (-1)	2.561 (-1)	7.403 (-4)	1.953 (-5)	2.178 (-7)	4.650 (-4)	1.734 (-4)	8.309 (-5)	4.462 (-7)
25,000	1.868 (-1)	2.699 (-5)	5.567 (-3)	2.127 (-3)	5.559 (-1)	2.477 (-1)	9.142 (-4)	2.609 (-5)	2.210 (-7)	4.801 (-4)	2.903 (-4)	1.180 (-4)	5.080 (-7)
26,000	1.479 (-1)	2.142 (-5)	5.382 (-3)	1.754 (-3)	6.029 (-1)	2.397 (-1)	1.157 (-3)	3.342 (-5)	3. 09 (-7)	4.809 (-4)	4.764 (-4)	1.662 (-4)	5.887 (-7)

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

Altitude=60,000 feet

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000	7.809 (-1)	2.098 (-1)	9.324 (-3)			1.380 (-26)							
3000	7.809 (-1)	2.098 (-1)	9.324 (-3)			1.097 (-16)							
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)	1.897 (-5)	8.958 (-23)	1.104 (-10)							
5000	7.807 (-1)	2.096 (-1)	9.324 (-3)	4.343 (-4)	1.095 (-15)	5.542 (-7)							
6000	7.792 (-1)	2.081 (-1)	9.323 (-3)	3.190 (-3)	3.356 (-11)	1.250 (-4)							
7000	7.738 (-1)	2.018 (-1)	9.306 (-3)	1.125 (-2)	2.521 (-8)	3.859 (-3)							
8000	7.588 (-1)	1.833 (-1)	9.205 (-3)	2.215 (-2)	1.086 (-6)	2.557 (-2)							
9000	7.386 (-1)	1.527 (-1)	9.081 (-3)	3.055 (-2)	9.211 (-6)	6.918 (-2)							
10,000	7.137 (-1)	1.155 (-1)	8.733 (-3)	3.529 (-2)	4.052 (-5)	1.267 (-1)							
11,000	6.882 (-1)	7.631 (-2)	8.434 (-3)	3.619 (-2)	1.385 (-4)	1.907 (-1)							
12,000	6.646 (-1)	3.919 (-2)	8.133 (-3)	3.268 (-2)	4.762 (-4)	2.549 (-1)							
13,000	6.469 (-1)	1.184 (-2)	7.880 (-3)	2.381 (-2)	2.253 (-3)	3.075 (-1)							
14,000	6.331 (-1)	2.105 (-3)	7.725 (-3)	1.411 (-2)	1.358 (-2)	3.293 (-1)	1.910 (-5)	8.364 (-10)	1.036 (-8)	1.912 (-5)	2.430 (-10)	1.347 (-8)	3.978 (-8)
15,000	6.079 (-1)	6.378 (-4)	7.579 (-3)	9.560 (-3)	4.403 (-2)	3.302 (-1)	5.312 (-5)	1.659 (-8)	2.523 (-8)	5.297 (-5)	1.207 (-8)	1.635 (-7)	6.966 (-8)
16,000	5.725 (-1)	3.097 (-4)	7.401 (-3)	7.430 (-3)	8.728 (-2)	3.249 (-1)	9.766 (-5)	9.951 (-8)	4.334 (-8)	9.675 (-5)	1.261 (-7)	7.399 (-7)	9.797 (-8)
17,000	5.317 (-1)	1.579 (-4)	7.204 (-3)	6.167 (-3)	1.370 (-1)	3.175 (-1)	1.477 (-4)	3.369 (-7)	6.316 (-8)	1.448 (-4)	5.293 (-7)	2.064 (-6)	1.284 (-7)
18,000	4.882 (-1)	1.279 (-4)	6.926 (-3)	5.238 (-3)	1.899 (-1)	3.091 (-1)	2.018 (-4)	8.398 (-7)	8.418 (-8)	1.944 (-4)	2.126 (-6)	4.530 (-6)	1.485 (-7)
19,000	4.434 (-1)	9.287 (-5)	6.782 (-3)	4.527 (-3)	2.444 (-1)	3.002 (-1)	2.601 (-4)	1.739 (-6)	1.062 (-7)	2.442 (-4)	5.695 (-6)	8.591 (-6)	1.739 (-7)
20,000	3.982 (-1)	7.022 (-5)	6.567 (-3)	3.936 (-3)	2.995 (-1)	2.912 (-1)	3.236 (-4)	3.179 (-6)	1.289 (-7)	2.926 (-4)	1.310 (-5)	1.481 (-5)	1.981 (-7)
21,000	3.531 (-1)	5.488 (-5)	6.354 (-3)	3.426 (-3)	3.543 (-1)	2.820 (-1)	3.944 (-4)	5.306 (-6)	1.520 (-7)	3.382 (-4)	2.712 (-5)	2.269 (-5)	2.229 (-7)
22,000	3.086 (-1)	4.296 (-5)	6.143 (-3)	2.972 (-3)	4.083 (-1)	2.730 (-1)	4.759 (-4)	8.255 (-6)	1.750 (-7)	3.791 (-4)	5.196 (-5)	3.676 (-5)	2.484 (-7)
23,000	2.651 (-1)	3.420 (-5)	5.937 (-3)	2.562 (-3)	4.612 (-1)	2.641 (-1)	5.737 (-4)	1.212 (-5)	1.975 (-7)	4.131 (-4)	9.396 (-5)	5.961 (-5)	2.790 (-7)
24,000	2.228 (-1)	2.732 (-5)	5.737 (-3)	2.185 (-3)	5.125 (-1)	2.554 (-1)	6.967 (-4)	1.694 (-5)	2.186 (-7)	4.380 (-4)	1.628 (-4)	7.810 (-5)	3.140 (-7)
25,000	1.820 (-1)	2.178 (-5)	5.543 (-3)	1.834 (-3)	5.618 (-1)	2.470 (-1)	8.600 (-4)	2.263 (-5)	2.378 (-7)	4.512 (-4)	2.735 (-4)	1.127 (-4)	3.575 (-7)
26,000	1.431 (-1)	1.722 (-5)	5.358 (-3)	1.506 (-3)	6.089 (-1)	2.390 (-1)	1.091 (-3)	2.898 (-5)	2.543 (-7)	4.506 (-4)	4.515 (-4)	1.597 (-4)	4.150 (-7)

Altitude: 170,000 feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000	7.809 (-1)	2.098 (-1)	9.324 (-3)			1.655 (-26)							
3000	7.809 (-1)	2.098 (-1)	9.324 (-3)			1.315 (-16)							
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)	1.897 (-5)	1.073 (-22)	1.324 (-10)							
5000	7.807 (-1)	2.096 (-1)	9.324 (-3)	4.343 (-4)	1.252 (-15)	6.644 (-7)							
6000	7.792 (-1)	2.081 (-1)	9.323 (-3)	3.188 (-3)	4.810 (-11)	1.495 (-4)							
7000	7.736 (-1)	2.015 (-1)	9.303 (-3)	1.113 (-2)	2.572 (-8)	4.498 (-3)							
8000	7.591 (-1)	1.820 (-1)	9.193 (-3)	2.145 (-2)	1.119 (-6)	2.819 (-2)							
9000	7.376 (-1)	1.507 (-1)	8.931 (-3)	2.915 (-2)	8.913 (-6)	7.353 (-2)							
10,000	7.126 (-1)	1.132 (-1)	8.708 (-3)	3.336 (-2)	3.813 (-5)	1.322 (-1)							
11,000	6.869 (-1)	7.373 (-2)	8.406 (-3)	3.394 (-2)	1.294 (-4)	1.969 (-1)							
12,000	6.634 (-1)	3.662 (-2)	8.104 (-3)	3.025 (-2)	4.526 (-4)	2.612 (-1)							
13,000	6.462 (-1)	9.879 (-3)	7.856 (-3)	2.130 (-2)	2.308 (-3)	3.125 (-1)							
14,000	6.322 (-1)	1.650 (-3)	7.710 (-3)	1.226 (-2)	1.472 (-2)	3.316 (-1)	1.929 (-5)	8.535 (-10)	8.941 (-9)	1.929 (-5)	2.754 (-10)	1.444 (-8)	2.950 (-8)
15,000	6.059 (-1)	5.070 (-4)	7.563 (-3)	8.327 (-3)	4.668 (-2)	3.309 (-1)	5.253 (-5)	1.608 (-8)	2.135 (-8)	5.236 (-5)	1.281 (-6)	1.678 (-7)	5.100 (-8)
16,000	5.696 (-1)	2.498 (-4)	7.323 (-3)	6.495 (-3)	9.089 (-2)	3.252 (-1)	9.501 (-5)	9.241 (-8)	3.620 (-8)	9.410 (-5)	1.268 (-7)	7.277 (-7)	7.116 (-8)
17,000	5.284 (-1)	1.528 (-4)	7.184 (-3)	5.384 (-3)	1.412 (-1)	3.175 (-1)	1.423 (-4)	3.051 (-7)	5.236 (-8)	1.394 (-4)	6.132 (-7)	2.004 (-6)	8.998 (-8)
18,000	4.845 (-1)	1.044 (-4)	6.975 (-3)	4.591 (-3)	1.945 (-1)	3.089 (-1)	1.932 (-4)	7.498 (-7)	6.951 (-8)	1.861 (-4)	2.037 (-6)	4.353 (-6)	1.078 (-7)
19,000	4.395 (-1)	7.604 (-5)	6.761 (-3)	3.969 (-3)	2.493 (-1)	2.999 (-1)	2.479 (-4)	1.528 (-6)	8.746 (-8)	2.328 (-4)	5.395 (-6)	8.186 (-6)	1.251 (-7)
20,000	3.941 (-1)	5.759 (-5)	6.546 (-3)	3.450 (-3)	3.045 (-1)	2.907 (-1)	3.074 (-4)	2.794 (-6)	1.060 (-7)	2.782 (-4)	1.235 (-5)	1.408 (-5)	1.423 (-7)
21,000	3.489 (-1)	4.471 (-5)	6.332 (-3)	3.001 (-3)	3.594 (-1)	2.815 (-1)	3.736 (-4)	4.645 (-6)	1.250 (-7)	3.209 (-4)	2.543 (-5)	2.267 (-5)	1.599 (-7)
22,000	3.044 (-1)	3.525 (-5)	6.122 (-3)	2.601 (-3)	4.135 (-1)	2.724 (-1)	4.498 (-4)	7.209 (-6)	1.440 (-7)	3.591 (-4)	4.864 (-5)	3.488 (-5)	1.757 (-7)
23,000	2.608 (-1)	2.804 (-5)	5.915 (-3)	2.238 (-3)	4.664 (-1)	2.635 (-1)	5.413 (-4)	1.057 (-5)	1.625 (-7)	3.909 (-4)	8.860 (-5)	5.187 (-5)	1.997 (-7)
24,000	2.185 (-1)	2.237 (-5)	5.715 (-3)	1.905 (-3)	5.178 (-1)	2.548 (-1)	6.567 (-4)	1.477 (-5)	1.801 (-7)	4.139 (-4)	1.527 (-4)	7.531 (-5)	2.246 (-7)
25,000	1.777 (-1)	1.780 (-5)	5.522 (-3)	1.595 (-3)	5.672 (-1)	2.463 (-1)	8.107 (-4)	1.972 (-5)	1.961 (-7)	4.257 (-4)	2.576 (-4)	1.077 (-4)	2.956 (-7)
26,000	1.388 (-1)	1.402 (-5)	5.337 (-3)	1.303 (-3)	6.142 (-1)	2.383 (-1)	1.030 (-3)	2.526 (-5)	2.101 (-7)	4.240 (-4)	4.278 (-4)	1.535 (-4)	3.678 (-7)

Altitude: 180,000 feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000	7.801 (-1)	2.098 (-1)	9.324 (-3)			8.478 (-27)							
3000	7.801 (-1)	2.098 (-1)	9.324 (-3)			1.069 (-16)							
4000	7.801 (-1)	2.098 (-1)	9.324 (-3)	1.780 (-5)	9.099 (-23)	1.314 (-10)							
5000	7.801 (-1)	2.098 (-1)	9.324 (-3)	4.205 (-4)	1.252 (-15)	7.197 (-7)							
6000	7.782 (-1)	2.081 (-1)	9.323 (-3)	3.131 (-3)	4.320 (-11)	1.685 (-4)							
7000	7.735 (-1)	2.013 (-1)	9.300 (-3)	1.091 (-2)	3.078 (-8)	5.053 (-3)							
8000	7.586 (-1)	1.810 (-1)	9.182 (-3)	2.071 (-2)	1.116 (-6)	3.042 (-2)							
9000	7.368 (-1)	1.482 (-1)	8.964 (-3)	2.782 (-2)	8.488 (-6)	7.722 (-2)							
10,000	7.116 (-1)	1.112 (-1)	8.686 (-3)	3.161 (-2)	3.556 (-5)	1.368 (-1)							
11,000	6.859 (-1)	7.158 (-2)	8.381 (-3)	3.196 (-2)	1.202 (-4)	2.021 (-1)							
12,000	6.624 (-1)	3.446 (-2)	8.079 (-3)	2.812 (-2)	4.281 (-4)	2.665 (-1)							
13,000	6.456 (-1)	5.457 (-3)	7.837 (-3)	1.916 (-2)	2.354 (-3)	3.166 (-1)							
14,000	6.318 (-1)	1.318 (-3)	7.698 (-3)	1.075 (-2)	1.577 (-2)	3.330 (-1)	1.935 (-5)	8.564 (-10)	7.735 (-9)	1.935 (-5)	3.035 (-10)	1.521 (-8)	2.286 (-8)
15,000	6.060 (-1)	4.106 (-4)	7.549 (-3)	7.323 (-3)	4.904 (-2)	3.315 (-1)	5.173 (-5)	1.540 (-8)	1.816 (-8)	5.155 (-5)	1.330 (-8)	1.699 (-7)	3.790 (-8)
16,000	5.671 (-1)	2.047 (-4)	7.368 (-3)	5.729 (-3)	9.408 (-2)	3.253 (-1)	9.229 (-5)	8.540 (-8)	3.046 (-8)	9.138 (-5)	1.258 (-7)	7.156 (-7)	5.255 (-8)
17,000	5.254 (-1)	1.261 (-4)	7.168 (-3)	4.757 (-3)	1.449 (-1)	3.174 (-1)	1.371 (-4)	2.762 (-7)	4.380 (-8)	1.343 (-4)	5.934 (-7)	1.939 (-6)	6.620 (-8)
18,000	4.818 (-1)	8.652 (-5)	6.958 (-3)	4.060 (-3)	1.965 (-1)	3.087 (-1)	1.851 (-4)	6.701 (-7)	5.794 (-8)	1.784 (-4)	1.940 (-6)	4.170 (-6)	7.946 (-8)
19,000	4.381 (-1)	6.315 (-5)	6.743 (-3)	3.510 (-3)	2.535 (-1)	2.996 (-1)	2.366 (-4)	1.364 (-6)	7.277 (-8)	2.224 (-4)	5.094 (-6)	7.812 (-6)	9.473 (-8)
20,000	3.806 (-1)	4.785 (-5)	6.528 (-3)	3.050 (-3)	3.089 (-1)	2.903 (-1)	2.926 (-4)	2.467 (-6)	8.815 (-8)	2.651 (-4)	1.159 (-5)	1.238 (-5)	1.042 (-7)
21,000	3.453 (-1)	3.717 (-5)	6.313 (-3)	2.651 (-3)	3.639 (-1)	2.811 (-1)	3.547 (-4)	4.088 (-6)	1.039 (-7)	2.053 (-4)	2.383 (-5)	2.152 (-5)	1.169 (-7)
22,000	3.007 (-1)	2.830 (-5)	6.103 (-3)	2.295 (-3)	4.181 (-1)	2.719 (-1)	4.262 (-4)	6.332 (-6)	1.197 (-7)	3.412 (-4)	4.554 (-5)	3.311 (-5)	1.305 (-7)
23,000	2.571 (-1)	2.329 (-5)	5.897 (-3)	1.973 (-3)	4.711 (-1)	2.629 (-1)	5.120 (-4)	9.277 (-6)	1.353 (-7)	3.710 (-4)	8.244 (-5)	4.990 (-5)	1.457 (-7)
24,000	2.167 (-1)	1.856 (-5)	5.696 (-3)	1.676 (-3)	5.225 (-1)	2.542 (-1)	6.206 (-4)	1.295 (-5)	1.501 (-7)	3.925 (-4)	1.434 (-4)	7.176 (-5)	1.637 (-7)
25,000	1.739 (-1)	1.473 (-5)	5.503 (-3)	1.399 (-3)	5.719 (-1)	2.457 (-1)	7.663 (-4)	1.731 (-5)	1.636 (-7)	4.032 (-4)	2.428 (-4)	1.034 (-4)	1.885 (-7)
26,000	1.350 (-1)	1.157 (-5)	5.318 (-3)	1.139 (-3)	6.190 (-1)	2.376 (-1)	9.757 (-4)	2.217 (-5)	1.755 (-7)	4.007 (-4)	4.054 (-4)	1.475 (-4)	2.171 (-7)

Altitude: 180,000 feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000													
3000	7.809 (-1)	2.088 (-1)	9.324 (-3)			5.480 (-17)							
4000	7.809 (-1)	2.088 (-1)	9.324 (-3)	1.548 (-5)	5.148 (-23)	1.050 (-10)							
5000	7.807 (-1)	2.096 (-1)	9.324 (-3)	3.919 (-4)	1.018 (-15)	6.967 (-7)							
6000	7.793 (-1)	2.082 (-1)	9.323 (-3)	3.012 (-3)	6.169 (-11)	1.782 (-4)							
7000	7.734 (-1)	2.012 (-1)	9.298 (-3)	1.059 (-2)	3.099 (-8)	5.476 (-3)							
8000	7.583 (-1)	1.803 (-1)	9.174 (-3)	1.991 (-2)	1.080 (-6)	3.222 (-2)							
9000	7.368 (-1)	1.480 (-1)	8.950 (-3)	2.653 (-2)	7.989 (-6)	8.023 (-2)							
10,000	7.109 (-1)	1.097 (-1)	8.668 (-3)	2.999 (-2)	3.283 (-5)	1.437 (-1)							
11,000	6.851 (-1)	6.985 (-2)	8.381 (-3)	3.012 (-2)	1.107 (-4)	2.066 (-1)							
12,000	6.616 (-1)	3.266 (-2)	8.058 (-3)	2.623 (-2)	4.018 (-4)	2.711 (-1)							
13,000	6.451 (-1)	7.304 (-3)	7.821 (-3)	1.731 (-2)	2.384 (-3)	3.200 (-1)							
14,000	6.307 (-1)	1.069 (-3)	7.687 (-3)	9.496 (-3)	1.671 (-2)	3.343 (-1)	1.926 (-5)	8.422 (-10)	6.630 (-9)	1.926 (-5)	3.245 (-10)	1.571 (-8)	1.674 (-8)
15,000	6.024 (-1)	3.369 (-4)	7.557 (-3)	6.482 (-3)	5.112 (-2)	3.320 (-1)	5.070 (-5)	1.456 (-8)	1.517 (-8)	5.051 (-5)	1.353 (-8)	1.697 (-7)	2.889 (-8)
16,000	5.649 (-1)	1.697 (-4)	7.354 (-3)	5.083 (-3)	9.689 (-2)	3.254 (-1)	8.944 (-5)	7.839 (-8)	2.572 (-8)	8.855 (-5)	1.233 (-7)	6.982 (-7)	3.946 (-8)
17,000	5.228 (-1)	1.051 (-4)	7.153 (-3)	4.226 (-3)	1.481 (-1)	3.174 (-1)	1.319 (-4)	2.492 (-7)	3.679 (-8)	1.293 (-4)	5.696 (-7)	1.867 (-6)	4.947 (-8)
18,000	4.785 (-1)	7.253 (-5)	6.942 (-3)	3.606 (-3)	2.021 (-1)	3.085 (-1)	1.774 (-4)	5.985 (-7)	4.853 (-8)	1.710 (-4)	1.840 (-6)	3.984 (-6)	5.870 (-8)
19,000	4.331 (-1)	5.288 (-5)	6.727 (-3)	3.120 (-3)	2.573 (-1)	2.993 (-1)	2.259 (-4)	1.210 (-6)	6.036 (-8)	2.125 (-4)	4.793 (-6)	7.429 (-6)	6.782 (-8)
20,000	3.875 (-1)	4.013 (-5)	6.511 (-3)	2.711 (-3)	3.127 (-1)	2.900 (-1)	2.785 (-4)	2.178 (-6)	7.357 (-8)	2.528 (-4)	1.085 (-5)	1.269 (-5)	7.705 (-8)
21,000	3.421 (-1)	3.116 (-5)	6.297 (-3)	2.355 (-3)	3.679 (-1)	2.806 (-1)	3.370 (-4)	3.600 (-6)	8.631 (-8)	2.907 (-4)	2.226 (-5)	2.039 (-5)	8.687 (-8)
22,000	2.974 (-1)	2.456 (-5)	6.086 (-3)	2.037 (-3)	4.222 (-1)	2.714 (-1)	4.041 (-4)	5.569 (-6)	1.031 (-7)	3.247 (-4)	4.252 (-5)	3.138 (-5)	9.629 (-8)
23,000	2.538 (-1)	1.951 (-5)	5.880 (-3)	1.749 (-3)	4.752 (-1)	2.624 (-1)	4.848 (-4)	8.155 (-6)	1.132 (-7)	3.528 (-4)	7.705 (-5)	4.680 (-5)	1.074 (-7)
24,000	2.114 (-1)	1.552 (-5)	5.680 (-3)	1.483 (-3)	5.266 (-1)	2.536 (-1)	5.870 (-4)	1.139 (-5)	1.257 (-7)	3.730 (-4)	1.344 (-4)	6.829 (-5)	1.206 (-7)
25,000	1.705 (-1)	1.230 (-5)	5.487 (-3)	1.235 (-3)	5.761 (-1)	2.452 (-1)	7.248 (-4)	1.522 (-5)	1.373 (-7)	3.828 (-4)	2.284 (-4)	9.843 (-5)	1.372 (-7)
26,000	1.315 (-1)	9.626 (-6)	5.302 (-3)	1.001 (-3)	6.232 (-1)	2.371 (-1)	9.246 (-4)	1.951 (-5)	1.474 (-7)	3.797 (-4)	3.836 (-4)	1.417 (-4)	1.600 (-7)

Altitude:200,000 feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000													
3000	7.809 (-1)	2.088 (-1)	9.324 (-3)			2.740 (-17)							
4000	7.809 (-1)	2.088 (-1)	9.324 (-3)	1.342 (-5)	2.882 (-23)	8.379 (-11)							
5000	7.807 (-1)	2.086 (-1)	9.324 (-3)	8.647 (-4)	8.285 (-16)	6.777 (-7)							
6000	7.794 (-1)	2.082 (-1)	9.323 (-3)	2.896 (-3)	4.008 (-11)	1.898 (-4)							
7000	7.734 (-1)	2.011 (-1)	9.296 (-3)	1.026 (-2)	3.123 (-8)	5.962 (-3)							
8000	7.580 (-1)	1.796 (-1)	8.165 (-3)	1.910 (-2)	1.040 (-6)	3.618 (-2)							
9000	7.357 (-1)	1.457 (-1)	6.935 (-3)	2.523 (-2)	7.399 (-6)	8.340 (-2)							
10.000	7.102 (-1)	1.081 (-1)	5.649 (-3)	2.635 (-2)	3.012 (-5)	1.447 (-1)							
11.000	6.843 (-1)	6.803 (-2)	3.340 (-3)	2.231 (-2)	1.014 (-4)	2.109 (-1)							
12.000	6.607 (-1)	3.081 (-2)	1.037 (-3)	2.436 (-2)	3.761 (-4)	2.757 (-1)							
13.000	6.447 (-1)	6.201 (-3)	7.805 (-3)	1.551 (-2)	2.434 (-3)	3.233 (-1)							
14.000	6.289 (-1)	8.561 (-4)	7.677 (-3)	8.327 (-3)	1.778 (-2)	3.358 (-1)	1.918 (-5)	8.296 (-10)	5.724 (-9)	1.917 (-5)	3.493 (-10)	1.628 (-8)	1.246 (-8)
15.000	6.007 (-1)	2.737 (-4)	7.525 (-3)	5.701 (-3)	5.335 (-2)	3.324 (-1)	4.959 (-5)	1.369 (-8)	1.305 (-8)	4.941 (-5)	1.373 (-8)	1.692 (-7)	2.033 (-8)
16.000	5.626 (-1)	1.393 (-4)	7.340 (-3)	4.483 (-3)	9.984 (-2)	3.255 (-1)	8.646 (-5)	7.148 (-8)	2.150 (-8)	8.560 (-5)	1.204 (-7)	6.790 (-7)	2.874 (-8)
17.000	5.201 (-1)	8.681 (-5)	7.138 (-3)	3.732 (-3)	1.515 (-1)	3.172 (-1)	1.267 (-4)	2.233 (-7)	3.060 (-8)	1.241 (-4)	5.442 (-7)	1.761 (-6)	3.586 (-8)
18.000	4.755 (-1)	5.994 (-5)	6.826 (-3)	3.188 (-3)	2.057 (-1)	3.082 (-1)	1.695 (-4)	5.306 (-7)	4.026 (-8)	1.634 (-4)	1.735 (-6)	3.791 (-6)	4.284 (-8)
19.000	4.300 (-1)	4.390 (-5)	6.711 (-3)	2.757 (-3)	2.611 (-1)	2.989 (-1)	2.151 (-4)	1.066 (-6)	5.040 (-8)	2.026 (-4)	4.487 (-6)	7.097 (-6)	4.949 (-8)
20.000	3.842 (-1)	3.335 (-5)	6.495 (-3)	2.395 (-3)	3.167 (-1)	2.896 (-1)	2.645 (-4)	1.909 (-5)	6.097 (-8)	2.405 (-4)	1.011 (-5)	1.198 (-5)	5.608 (-8)
21.000	3.388 (-1)	2.591 (-5)	6.280 (-3)	2.079 (-3)	3.720 (-1)	2.802 (-1)	3.193 (-4)	3.147 (-6)	7.185 (-8)	2.762 (-4)	2.069 (-5)	1.825 (-5)	6.280 (-8)
22.000	2.941 (-1)	2.042 (-5)	6.069 (-3)	1.797 (-3)	4.253 (-1)	2.709 (-1)	3.822 (-4)	4.862 (-6)	8.288 (-8)	3.082 (-4)	3.951 (-5)	2.963 (-5)	6.993 (-8)
23.000	2.503 (-1)	1.620 (-5)	5.863 (-3)	1.581 (-3)	4.796 (-1)	2.619 (-1)	4.578 (-4)	7.116 (-6)	9.383 (-8)	3.347 (-4)	7.167 (-5)	4.826 (-5)	7.792 (-8)
24.000	2.079 (-1)	1.288 (-5)	5.663 (-3)	1.309 (-3)	5.309 (-1)	2.531 (-1)	5.537 (-4)	9.988 (-6)	1.044 (-7)	3.537 (-4)	1.253 (-4)	6.977 (-5)	8.743 (-8)
25.000	1.671 (-1)	1.018 (-5)	5.470 (-3)	1.088 (-3)	5.808 (-1)	2.446 (-1)	6.835 (-4)	1.329 (-5)	1.142 (-7)	3.626 (-4)	2.138 (-4)	9.874 (-5)	9.854 (-8)
26.000	1.281 (-1)	7.940 (-6)	5.285 (-3)	8.738 (-4)	6.275 (-1)	2.365 (-1)	8.734 (-4)	1.705 (-5)	1.228 (-7)	3.591 (-4)	3.615 (-4)	1.357 (-4)	1.101 (-7)

Altitude:210,000 feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000													
3000													
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)	1.159 (-5)	1.599 (-23)	6.682 (-11)							
5000	7.607 (-1)	2.096 (-1)	9.324 (-3)	3.391 (-4)	6.768 (-16)	6.682 (-7)							
6000	7.784 (-1)	2.083 (-1)	9.323 (-3)	2.784 (-3)	3.897 (-11)	2.038 (-4)							
7000	7.734 (-1)	2.009 (-1)	9.294 (-3)	9.927 (-3)	3.151 (-8)	6.523 (-3)							
8000	7.576 (-1)	1.787 (-1)	9.155 (-3)	1.826 (-2)	9.959 (-7)	3.629 (-2)							
9000	7.351 (-1)	1.454 (-1)	8.920 (-3)	2.390 (-2)	6.841 (-6)	8.674 (-2)							
10,000	7.094 (-1)	1.084 (-1)	8.630 (-3)	2.670 (-2)	2.744 (-5)	1.488 (-1)							
11,000	6.844 (-1)	6.614 (-2)	8.319 (-3)	2.650 (-2)	9.237 (-5)	2.156 (-1)							
12,000	6.598 (-1)	2.889 (-2)	8.015 (-3)	2.250 (-2)	3.510 (-4)	2.804 (-1)							
13,000	6.443 (-1)	5.159 (-3)	7.790 (-3)	1.375 (-2)	2.508 (-3)	3.265 (-1)							
14,000	6.280 (-1)	6.759 (-4)	7.667 (-3)	7.235 (-3)	1.899 (-2)	3.364 (-1)	1.910 (-5)	8.178 (-10)	4.861 (-9)	1.909 (-5)	3.783 (-10)	1.692 (-8)	9.113 (-9)
15,000	5.988 (-1)	2.201 (-4)	7.513 (-3)	4.979 (-3)	5.574 (-2)	3.326 (-1)	4.840 (-5)	1.280 (-8)	1.090 (-8)	4.821 (-5)	1.389 (-8)	1.683 (-7)	1.516 (-8)
16,000	5.601 (-1)	1.133 (-4)	7.326 (-3)	3.927 (-3)	1.029 (-1)	3.254 (-1)	8.336 (-5)	6.470 (-8)	1.778 (-8)	8.252 (-5)	1.170 (-7)	6.578 (-7)	2.068 (-8)
17,000	5.173 (-1)	7.101 (-5)	7.122 (-3)	3.279 (-3)	1.550 (-1)	3.170 (-1)	1.212 (-4)	1.985 (-7)	2.518 (-8)	1.188 (-4)	5.172 (-7)	1.711 (-6)	2.583 (-8)
18,000	4.725 (-1)	4.920 (-5)	6.910 (-3)	2.799 (-3)	2.096 (-1)	3.079 (-1)	1.615 (-4)	4.666 (-7)	3.303 (-8)	1.558 (-4)	1.628 (-6)	3.592 (-6)	3.971 (-8)
19,000	4.268 (-1)	3.611 (-5)	6.694 (-3)	2.420 (-3)	2.651 (-1)	2.986 (-1)	2.048 (-4)	9.305 (-7)	4.129 (-8)	1.925 (-4)	4.176 (-6)	6.636 (-6)	5.543 (-8)
20,000	3.809 (-1)	2.745 (-5)	6.478 (-3)	2.102 (-3)	3.209 (-1)	2.891 (-1)	2.505 (-4)	1.660 (-6)	4.992 (-8)	2.281 (-4)	9.364 (-6)	1.127 (-5)	6.010 (-8)
21,000	3.354 (-1)	2.134 (-5)	6.263 (-3)	1.824 (-3)	3.762 (-1)	2.797 (-1)	3.016 (-4)	2.728 (-6)	5.883 (-8)	2.616 (-4)	1.912 (-5)	1.809 (-5)	6.485 (-8)
22,000	2.906 (-1)	1.661 (-5)	6.052 (-3)	1.575 (-3)	4.306 (-1)	2.704 (-1)	3.603 (-4)	4.208 (-6)	6.790 (-8)	2.917 (-4)	3.648 (-5)	2.785 (-5)	6.929 (-8)
23,000	2.469 (-1)	1.333 (-5)	5.856 (-3)	1.348 (-3)	4.837 (-1)	2.613 (-1)	4.309 (-4)	6.156 (-6)	7.696 (-8)	3.166 (-4)	6.627 (-5)	4.168 (-5)	7.551 (-8)
24,000	2.064 (-1)	1.058 (-5)	5.686 (-3)	1.139 (-3)	5.352 (-1)	2.525 (-1)	5.201 (-4)	8.600 (-6)	8.575 (-8)	3.378 (-4)	1.162 (-4)	6.118 (-5)	8.224 (-8)
25,000	1.695 (-1)	8.348 (-6)	5.553 (-3)	9.631 (-4)	5.848 (-1)	2.440 (-1)	6.429 (-4)	1.151 (-5)	9.396 (-8)	3.627 (-4)	1.992 (-4)	8.894 (-5)	7.083 (-8)
26,000	1.365 (-1)	6.485 (-6)	5.269 (-3)	7.577 (-4)	6.319 (-1)	2.358 (-1)	8.222 (-4)	1.478 (-5)	1.013 (-7)	3.388 (-4)	3.390 (-4)	1.296 (-4)	8.270 (-8)

Altitude: 220,000feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000													
3000													
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)	9.968 (-6)	8.781 (-24)	5.330 (-11)							
5000	7.807 (-1)	2.096 (-1)	9.324 (-3)	3.148 (-4)	5.550 (-16)	6.538 (-7)							
6000	7.795 (-1)	2.083 (-1)	9.323 (-3)	2.674 (-3)	3.818 (-11)	2.207 (-4)							
7000	7.733 (-1)	2.007 (-1)	9.291 (-3)	9.584 (-3)	3.181 (-8)	7.174 (-3)							
8000	7.571 (-1)	1.778 (-1)	9.194 (-3)	1.789 (-2)	9.677 (-7)	3.859 (-2)							
9000	7.344 (-1)	1.439 (-1)	8.903 (-3)	2.256 (-2)	6.277 (-6)	9.025 (-2)							
10,000	7.086 (-1)	1.046 (-1)	8.610 (-3)	2.505 (-2)	2.481 (-5)	1.531 (-1)							
11,000	6.824 (-1)	6.615 (-2)	8.296 (-3)	2.469 (-2)	8.353 (-5)	2.203 (-1)							
12,000	6.589 (-1)	2.691 (-2)	7.988 (-3)	2.067 (-2)	3.266 (-4)	2.852 (-1)							
13,000	6.436 (-1)	4.182 (-3)	7.776 (-3)	1.205 (-2)	2.615 (-3)	3.295 (-1)							
14,000	6.379 (-1)	5.258 (-4)	7.657 (-3)	6.236 (-3)	2.036 (-2)	3.373 (-1)	1.901 (-5)	8.056 (-10)	4.086 (-9)	1.899 (-5)	4.116 (-10)	1.761 (-8)	6.540 (-9)
15,000	6.368 (-1)	1.748 (-4)	7.500 (-3)	4.316 (-3)	5.831 (-2)	3.328 (-1)	4.711 (-5)	1.188 (-8)	8.894 (-9)	4.692 (-5)	1.401 (-8)	1.668 (-7)	1.076 (-8)
16,000	5.575 (-1)	9.110 (-5)	7.311 (-3)	3.815 (-3)	1.062 (-1)	3.258 (-1)	8.013 (-5)	5.807 (-8)	1.453 (-8)	7.932 (-5)	1.131 (-7)	6.345 (-7)	1.461 (-8)
17,000	5.183 (-1)	5.746 (-5)	7.106 (-3)	2.851 (-3)	1.587 (-1)	3.167 (-1)	1.157 (-4)	1.749 (-7)	2.047 (-8)	1.134 (-4)	9.886 (-7)	1.626 (-6)	1.818 (-8)
18,000	4.693 (-1)	3.995 (-5)	6.838 (-3)	2.439 (-3)	2.135 (-1)	3.075 (-1)	1.523 (-4)	4.065 (-7)	2.678 (-8)	1.480 (-4)	1.517 (-6)	3.387 (-6)	2.358 (-8)
19,000	4.234 (-1)	2.938 (-5)	6.577 (-3)	2.109 (-3)	2.692 (-1)	2.861 (-1)	1.933 (-4)	8.049 (-7)	3.342 (-8)	1.824 (-4)	2.861 (-6)	6.226 (-6)	2.488 (-8)
20,000	3.775 (-1)	2.236 (-5)	6.481 (-3)	1.831 (-3)	3.251 (-1)	2.886 (-1)	2.363 (-4)	1.429 (-6)	4.037 (-8)	2.157 (-4)	8.616 (-6)	1.055 (-5)	2.619 (-8)
21,000	3.319 (-1)	1.739 (-5)	6.246 (-3)	1.588 (-3)	3.805 (-1)	2.792 (-1)	2.839 (-4)	2.343 (-6)	4.758 (-8)	2.471 (-4)	1.755 (-5)	1.691 (-5)	2.789 (-8)
22,000	2.871 (-1)	1.370 (-5)	6.035 (-3)	1.371 (-3)	4.349 (-1)	2.699 (-1)	3.384 (-4)	3.607 (-6)	5.496 (-8)	2.752 (-4)	3.347 (-5)	2.606 (-5)	2.988 (-8)
23,000	2.433 (-1)	1.086 (-5)	5.829 (-3)	1.172 (-3)	4.881 (-1)	2.608 (-1)	4.039 (-4)	5.275 (-6)	6.238 (-8)	2.987 (-4)	6.066 (-5)	3.906 (-5)	3.279 (-8)
24,000	2.008 (-1)	8.602 (-6)	5.628 (-3)	9.878 (-4)	5.396 (-1)	2.519 (-1)	4.873 (-4)	7.374 (-6)	6.963 (-8)	3.154 (-4)	1.070 (-4)	5.753 (-5)	4.348 (-8)
25,000	1.600 (-1)	6.789 (-6)	5.436 (-3)	8.154 (-4)	5.892 (-1)	2.434 (-1)	6.018 (-4)	9.879 (-6)	7.646 (-8)	3.230 (-4)	1.844 (-4)	8.403 (-5)	4.848 (-8)
26,000	1.209 (-1)	5.240 (-6)	5.251 (-3)	6.518 (-4)	6.368 (-1)	2.352 (-1)	7.710 (-4)	1.270 (-5)	8.258 (-8)	3.187 (-4)	3.162 (-4)	1.283 (-4)	5.772 (-8)

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

Altitude:230,000 feet

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000													
3000													
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)	8.541 (-6)	3.789 (-24)	4.254 (-11)							
5000	7.807 (-1)	2.096 (-1)	9.324 (-3)	2.919 (-4)	4.573 (-18)	6.496 (-7)							
6000	7.795 (-1)	2.084 (-1)	9.323 (-3)	2.567 (-3)	3.773 (-11)	2.915 (-4)							
7000	7.732 (-1)	2.004 (-1)	9.287 (-3)	9.231 (-3)	3.211 (-8)	7.930 (-3)							
8000	7.586 (-1)	1.767 (-1)	9.132 (-3)	1.650 (-2)	8.952 (-7)	4.109 (-2)							
9000	7.334 (-1)	1.421 (-1)	8.884 (-3)	2.123 (-2)	5.769 (-6)	9.433 (-2)							
10,000	7.076 (-1)	1.027 (-1)	8.588 (-3)	2.340 (-2)	2.232 (-5)	1.577 (-1)							
11,000	6.814 (-1)	6.206 (-2)	8.273 (-3)	2.290 (-2)	7.503 (-5)	2.253 (-1)							
12,000	6.579 (-1)	2.487 (-2)	7.970 (-3)	1.885 (-2)	3.049 (-4)	2.901 (-1)							
13,000	6.435 (-1)	3.316 (-3)	7.762 (-3)	1.042 (-2)	2.763 (-3)	3.322 (-1)							
14,000	6.267 (-1)	4.028 (-4)	7.646 (-3)	5.324 (-3)	2.190 (-2)	3.379 (-1)	1.889 (-5)	7.918 (-10)	3.394 (-9)	1.887 (-5)	4.492 (-10)	1.835 (-8)	8.598 (-9)
14,000	6.267 (-1)	4.028 (-4)	7.646 (-3)	5.324 (-3)	2.190 (-2)	3.379 (-1)	4.572 (-5)	1.093 (-8)	7.329 (-9)	4.553 (-5)	1.406 (-8)	1.646 (-7)	7.473 (-9)
15,000	5.946 (-1)	1.371 (-4)	7.487 (-3)	3.709 (-3)	6.105 (-2)	3.329 (-1)	7.676 (-5)	5.163 (-8)	1.172 (-8)	7.589 (-5)	1.086 (-7)	6.091 (-7)	1.009 (-8)
16,000	5.547 (-1)	7.236 (-5)	7.296 (-3)	2.945 (-3)	1.096 (-1)	3.252 (-1)	1.100 (-4)	1.526 (-7)	1.662 (-8)	1.079 (-4)	4.584 (-7)	1.538 (-6)	1.252 (-8)
17,000	5.112 (-1)	4.594 (-5)	7.090 (-3)	2.462 (-3)	1.675 (-1)	3.164 (-1)	1.451 (-4)	3.506 (-7)	2.114 (-8)	1.401 (-4)	1.404 (-6)	3.176 (-6)	1.488 (-8)
18,000	4.660 (-1)	3.206 (-5)	6.876 (-3)	2.108 (-3)	2.176 (-1)	3.071 (-1)	1.822 (-4)	6.891 (-7)	2.664 (-8)	1.722 (-4)	3.544 (-6)	5.810 (-6)	1.706 (-8)
19,000	4.200 (-1)	2.362 (-5)	6.660 (-3)	1.823 (-3)	2.735 (-1)	2.976 (-1)	2.221 (-4)	1.216 (-6)	3.221 (-8)	2.032 (-4)	7.270 (-6)	9.820 (-6)	1.926 (-8)
20,000	3.740 (-1)	1.800 (-5)	6.442 (-3)	1.582 (-3)	3.294 (-1)	2.881 (-1)	2.662 (-4)	1.990 (-6)	3.797 (-8)	2.325 (-4)	1.599 (-5)	1.572 (-5)	2.148 (-8)
21,000	3.283 (-1)	1.401 (-5)	6.228 (-3)	1.372 (-3)	3.849 (-1)	2.786 (-1)	2.652 (-4)	1.990 (-6)	3.797 (-8)	2.325 (-4)	1.599 (-5)	1.572 (-5)	2.148 (-8)
22,000	2.835 (-1)	1.103 (-5)	6.017 (-3)	1.185 (-3)	4.396 (-1)	2.693 (-1)	3.166 (-4)	3.060 (-6)	4.390 (-8)	2.588 (-4)	3.048 (-5)	2.424 (-5)	2.285 (-8)
23,000	2.357 (-1)	8.736 (-6)	5.811 (-3)	1.010 (-3)	4.926 (-1)	2.602 (-1)	3.771 (-4)	4.473 (-6)	4.989 (-8)	2.807 (-4)	5.550 (-5)	3.641 (-5)	2.648 (-8)
24,000	1.872 (-1)	6.913 (-6)	5.611 (-3)	8.495 (-4)	5.441 (-1)	2.513 (-1)	4.544 (-4)	6.254 (-6)	5.580 (-8)	2.964 (-4)	9.789 (-5)	5.380 (-5)	2.962 (-8)
25,000	1.563 (-1)	5.425 (-6)	5.418 (-3)	6.989 (-4)	5.938 (-1)	2.427 (-1)	5.605 (-4)	8.389 (-6)	6.142 (-8)	3.034 (-4)	1.696 (-4)	7.902 (-5)	3.368 (-8)
26,000	1.173 (-1)	4.183 (-6)	5.234 (-3)	5.559 (-4)	6.410 (-1)	2.345 (-1)	7.199 (-4)	1.080 (-5)	6.651 (-8)	2.990 (-4)	2.932 (-4)	1.168 (-4)	3.938 (-8)

Altitude: 240,000 feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

	MOLE FRACTION CONCENTRATIONS												
V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000													
3000													
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)	7.289 (-6)	2.589 (-26)	3.404 (-11)							
5000	7.807 (-1)	2.097 (-1)	9.324 (-3)	2.703 (-4)	3.788 (-16)	6.518 (-7)							
6000	7.795 (-1)	2.094 (-1)	9.323 (-3)	2.462 (-3)	3.765 (-11)	2.673 (-4)							
7000	7.730 (-1)	2.000 (-1)	9.293 (-3)	8.889 (-3)	3.238 (-8)	8.816 (-3)							
8000	7.560 (-1)	1.755 (-1)	9.120 (-3)	1.559 (-2)	8.384 (-7)	4.381 (-2)							
9000	7.326 (-1)	1.404 (-1)	8.856 (-3)	1.986 (-2)	5.202 (-6)	9.831 (-2)							
10,000	7.066 (-1)	1.006 (-1)	8.586 (-3)	2.176 (-2)	1.983 (-5)	1.625 (-1)							
11,000	6.803 (-1)	5.886 (-2)	8.250 (-3)	2.181 (-2)	6.677 (-5)	2.384 (-1)							
12,000	6.569 (-1)	2.275 (-2)	7.967 (-3)	1.705 (-2)	2.806 (-4)	2.951 (-1)							
13,000	6.431 (-1)	2.543 (-3)	7.749 (-3)	8.882 (-3)	2.967 (-3)	3.348 (-1)							
14,000	6.254 (-1)	8.032 (-4)	7.636 (-3)	4.497 (-3)	2.364 (-2)	3.395 (-1)	1.875 (-5)	7.750 (-10)	2.780 (-9)	1.873 (-5)	4.911 (-10)	1.912 (-8)	3.197 (-9)
15,000	5.823 (-1)	1.080 (-4)	7.473 (-3)	3.157 (-3)	6.399 (-2)	3.329 (-1)	4.421 (-5)	9.965 (-9)	5.876 (-9)	4.402 (-5)	1.403 (-8)	1.617 (-7)	5.060 (-9)
16,000	5.518 (-1)	5.668 (-5)	7.281 (-3)	2.515 (-3)	1.132 (-1)	3.249 (-1)	7.324 (-5)	4.590 (-8)	9.303 (-9)	7.251 (-5)	1.036 (-7)	5.814 (-7)	6.782 (-9)
17,000	5.080 (-1)	3.823 (-5)	7.073 (-3)	2.107 (-3)	1.685 (-1)	3.160 (-1)	1.092 (-4)	1.316 (-7)	1.297 (-8)	1.022 (-4)	4.268 (-7)	1.946 (-6)	8.905 (-9)
18,000	4.625 (-1)	2.538 (-5)	6.859 (-3)	1.805 (-3)	2.218 (-1)	3.067 (-1)	1.367 (-4)	2.958 (-7)	1.686 (-8)	1.321 (-4)	1.289 (-6)	2.960 (-6)	9.987 (-9)
19,000	4.164 (-1)	1.875 (-5)	6.642 (-3)	1.561 (-3)	2.779 (-1)	2.971 (-1)	1.711 (-4)	5.829 (-7)	2.098 (-8)	1.618 (-4)	3.226 (-6)	5.387 (-6)	1.161 (-8)
20,000	3.703 (-1)	1.630 (-5)	6.425 (-3)	1.355 (-3)	3.339 (-1)	2.875 (-1)	2.079 (-4)	1.025 (-6)	2.531 (-8)	1.907 (-4)	7.127 (-6)	9.080 (-6)	1.257 (-8)
21,000	3.246 (-1)	1.113 (-5)	6.210 (-3)	1.176 (-3)	3.894 (-1)	2.780 (-1)	2.485 (-4)	1.670 (-6)	2.[illegible] (-8)	2.178 (-4)	1.444 (-5)	1.453 (-5)	1.484 (-8)
22,000	2.798 (-1)	8.766 (-6)	5.999 (-3)	1.011 (-3)	4.440 (-1)	2.687 (-1)	2.949 (-4)	2.564 (-6)	3.453 (-8)	2.424 (-4)	2.752 (-5)	2.241 (-5)	1.583 (-8)
23,000	2.360 (-1)	6.837 (-6)	5.788 (-3)	8.520 (-4)	4.972 (-1)	2.595 (-1)	3.506 (-4)	3.747 (-6)	3.930 (-8)	2.629 (-4)	5.018 (-5)	3.873 (-5)	1.782 (-8)
24,000	1.926 (-1)	5.481 (-6)	5.583 (-3)	7.236 (-4)	5.487 (-1)	2.506 (-1)	4.217 (-4)	5.242 (-6)	4.405 (-8)	2.775 (-4)	8.883 (-5)	6.003 (-5)	1.989 (-8)
25,000	1.525 (-1)	4.290 (-6)	5.400 (-3)	5.933 (-4)	5.884 (-1)	2.420 (-1)	5.199 (-4)	7.041 (-6)	4.863 (-8)	2.841 (-4)	1.543 (-4)	7.391 (-5)	2.237 (-8)
26,000	1.135 (-1)	3.293 (-6)	5.216 (-3)	4.698 (-4)	6.156 (-1)	2.339 (-1)	6.689 (-4)	9.075 (-6)	5.281 (-8)	2.796 (-4)	2.700 (-4)	1.102 (-4)	2.618 (-8)

Altitude: 250,000 feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000													
3000													
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)	6.195 (-6)	1.391 (-24)	2.734 (-11)							
5000	7.808 (-1)	2.097 (-1)	9.324 (-3)	2.500 (-4)	3.172 (-16)	6.616 (-7)							
6000	7.796 (-1)	2.084 (-1)	9.323 (-3)	2.361 (-3)	3.802 (-11)	2.999 (-4)							
7000	7.728 (-1)	1.996 (-1)	9.278 (-3)	8.482 (-3)	3.258 (-8)	9.858 (-3)							
8000	7.553 (-1)	1.742 (-1)	9.106 (-3)	1.465 (-2)	7.772 (-7)	4.677 (-2)							
9000	7.316 (-1)	1.385 (-1)	8.846 (-3)	1.847 (-2)	4.639 (-6)	1.625 (-1)							
10,000	7.055 (-1)	9.849 (-2)	8.543 (-3)	2.008 (-2)	1.742 (-5)	1.674 (-1)							
11,000	6.791 (-1)	5.758 (-2)	8.225 (-3)	1.934 (-2)	5.885 (-5)	2.357 (-1)							
12,000	6.558 (-1)	2.056 (-2)	7.923 (-3)	1.529 (-2)	2.593 (-4)	3.002 (-1)							
13,000	6.427 (-1)	1.883 (-3)	7.736 (-3)	7.440 (-3)	3.243 (-3)	3.570 (-1)							
14,000	6.238 (-1)	2.240 (-4)	7.625 (-3)	3.755 (-3)	2.560 (-2)	3.389 (-1)	1.856 (-5)	7.539 (-10)	2.231 (-9)	1.853 (-5)	5.369 (-10)	1.888 (-8)	2.097 (-9)
15,000	5.898 (-1)	8.065 (-5)	7.459 (-3)	2.658 (-3)	6.716 (-2)	3.328 (-1)	4.257 (-5)	8.979 (-9)	4.633 (-9)	4.239 (-5)	1.390 (-8)	1.560 (-7)	3.829 (-9)
16,000	5.488 (-1)	4.371 (-5)	7.264 (-3)	2.126 (-3)	1.170 (-1)	3.246 (-1)	6.558 (-5)	3.943 (-8)	7.260 (-9)	6.889 (-5)	9.800 (-8)	5.513 (-7)	4.444 (-9)
17,000	5.046 (-1)	2.814 (-5)	7.056 (-3)	1.784 (-3)	1.707 (-1)	3.156 (-1)	9.819 (-5)	1.120 (-7)	1.007 (-8)	9.633 (-5)	3.938 (-7)	1.350 (-6)	5.982 (-9)
18,000	4.589 (-1)	1.979 (-5)	6.841 (-3)	1.529 (-3)	2.263 (-1)	3.061 (-1)	1.282 (-4)	2.513 (-7)	1.305 (-8)	1.240 (-4)	1.173 (-6)	2.789 (-6)	6.466 (-9)
19,000	4.127 (-1)	1.465 (-5)	6.623 (-3)	1.323 (-3)	2.825 (-1)	2.965 (-1)	1.588 (-4)	4.864 (-7)	1.621 (-8)	1.514 (-4)	2.908 (-6)	4.958 (-6)	7.419 (-9)
20,000	3.665 (-1)	1.119 (-5)	6.406 (-3)	1.148 (-3)	3.386 (-1)	2.869 (-1)	1.937 (-4)	8.511 (-7)	1.954 (-8)	1.781 (-4)	6.292 (-6)	8.335 (-6)	8.354 (-9)
21,000	3.208 (-1)	8.714 (-6)	6.191 (-3)	9.941 (-4)	3.941 (-1)	2.774 (-1)	2.308 (-4)	1.363 (-6)	2.304 (-8)	2.032 (-4)	1.292 (-5)	1.332 (-5)	9.298 (-9)
22,000	2.759 (-1)	6.862 (-6)	5.980 (-3)	8.553 (-4)	4.487 (-1)	2.680 (-1)	2.733 (-4)	2.119 (-6)	2.659 (-8)	2.260 (-4)	2.461 (-5)	2.057 (-5)	1.029 (-8)
23,000	2.321 (-1)	5.425 (-6)	5.774 (-3)	7.281 (-4)	5.019 (-1)	2.588 (-1)	3.241 (-4)	3.095 (-6)	3.043 (-8)	2.451 (-4)	4.495 (-5)	3.103 (-5)	1.139 (-8)
24,000	1.896 (-1)	4.280 (-6)	5.574 (-3)	6.098 (-4)	5.535 (-1)	2.499 (-1)	3.892 (-4)	4.334 (-6)	3.420 (-8)	2.588 (-4)	7.987 (-5)	4.622 (-5)	1.271 (-8)
25,000	1.487 (-1)	3.341 (-6)	5.382 (-3)	4.983 (-4)	6.031 (-1)	2.413 (-1)	4.794 (-4)	5.830 (-6)	3.786 (-8)	2.649 (-4)	1.400 (-4)	6.868 (-5)	1.443 (-8)
26,000	1.097 (-1)	2.553 (-6)	5.198 (-3)	3.918 (-4)	6.504 (-1)	2.331 (-1)	6.180 (-4)	7.529 (-6)	4.126 (-8)	2.604 (-4)	2.467 (-4)	1.034 (-4)	1.690 (-8)

Altitude: 200,000 feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000													
3000													
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)	5.242 (-6)	7.424 (-25)	2.207 (-11)							
5000	7.808 (-1)	2.097 (-1)	9.324 (-3)	2.309 (-4)	2.679 (-16)	6.807 (-7)							
6000	7.796 (-1)	2.085 (-1)	9.322 (-3)	2.261 (-3)	3.893 (-11)	3.415 (-4)							
7000	7.725 (-1)	1.990 (-1)	9.272 (-3)	8.081 (-3)	3.265 (-8)	1.109 (-2)							
8000	7.545 (-1)	1.727 (-1)	9.091 (-3)	1.368 (-2)	7.120 (-7)	5.001 (-2)							
9000	7.306 (-1)	1.365 (-1)	8.825 (-3)	1.707 (-2)	4.084 (-6)	1.070 (-1)							
10.000	7.043 (-1)	9.618 (-2)	8.519 (-3)	1.843 (-2)	1.512 (-5)	1.726 (-1)							
11.000	6.779 (-1)	5.509 (-2)	8.199 (-3)	1.759 (-2)	5.131 (-5)	2.412 (-1)							
12.000	6.547 (-1)	1.830 (-2)	7.899 (-3)	1.355 (-2)	2.363 (-4)	3.053 (-1)							
13.000	6.423 (-1)	1.341 (-3)	7.727 (-3)	6.113 (-3)	3.615 (-3)	3.389 (-1)							
14.000	6.721 (-1)	1.520 (-4)	7.613 (-3)	3.093 (-3)	2.783 (-2)	3.392 (-1)	1.832 (-5)	7.284 (-10)	1.774 (-9)	1.830 (-5)	5.872 (-10)	2.065 (-8)	1.852 (-8)
15.000	5.870 (-1)	6.020 (-5)	7.944 (-3)	2.210 (-3)	7.060 (-2)	3.326 (-1)	4.081 (-5)	7.992 (-9)	3.589 (-9)	4.064 (-5)	1.368 (-8)	1.584 (-7)	2.120 (-8)
16.000	5.455 (-1)	3.310 (-5)	7.247 (-3)	1.775 (-3)	1.211 (-1)	3.242 (-1)	6.578 (-5)	3.378 (-8)	5.555 (-9)	6.513 (-5)	9.190 (-8)	5.182 (-7)	2.843 (-8)
17.000	5.010 (-1)	2.146 (-5)	7.038 (-3)	1.492 (-3)	1.752 (-1)	3.151 (-1)	9.209 (-5)	9.398 (-8)	7.658 (-9)	9.038 (-5)	3.600 (-7)	1.251 (-6)	3.459 (-8)
18.000	4.552 (-1)	1.516 (-5)	6.822 (-3)	1.280 (-3)	2.309 (-1)	3.056 (-1)	1.196 (-4)	2.082 (-7)	9.895 (-9)	1.158 (-4)	1.056 (-6)	2.515 (-6)	4.674 (-8)
19.000	4.088 (-1)	1.125 (-5)	6.604 (-3)	1.108 (-3)	2.872 (-1)	2.959 (-1)	1.485 (-4)	3.998 (-7)	1.227 (-8)	1.410 (-4)	2.596 (-6)	4.528 (-6)	4.666 (-8)
20.000	3.626 (-1)	8.603 (-6)	6.387 (-3)	9.611 (-4)	3.435 (-1)	2.863 (-1)	1.791 (-4)	6.959 (-7)	1.479 (-8)	1.654 (-4)	5.672 (-6)	7.589 (-6)	5.247 (-8)
21.000	3.168 (-1)	6.704 (-6)	6.172 (-3)	8.316 (-4)	3.990 (-1)	2.767 (-1)	2.132 (-4)	1.127 (-6)	1.788 (-8)	1.886 (-4)	1.143 (-5)	1.212 (-5)	5.884 (-8)
22.000	2.719 (-1)	5.278 (-6)	5.961 (-3)	7.148 (-4)	4.536 (-1)	2.673 (-1)	2.518 (-4)	1.724 (-6)	2.022 (-8)	2.096 (-4)	2.177 (-5)	1.872 (-5)	6.444 (-8)
23.000	2.281 (-1)	4.170 (-6)	5.755 (-3)	6.075 (-4)	5.068 (-1)	2.581 (-1)	2.980 (-4)	2.518 (-6)	2.310 (-8)	2.273 (-4)	3.983 (-5)	2.882 (-5)	7.124 (-8)
24.000	1.856 (-1)	3.284 (-6)	5.555 (-3)	5.076 (-4)	5.584 (-1)	2.492 (-1)	3.571 (-4)	3.528 (-6)	2.603 (-8)	2.461 (-4)	7.107 (-5)	4.238 (-5)	7.887 (-8)
25.000	1.447 (-1)	2.556 (-6)	5.363 (-3)	4.132 (-4)	6.060 (-1)	2.406 (-1)	4.395 (-4)	4.755 (-6)	2.892 (-8)	2.658 (-4)	1.255 (-4)	6.341 (-5)	8.000 (-8)
26.000	1.057 (-1)	1.963 (-6)	5.179 (-3)	3.228 (-4)	6.552 (-1)	2.324 (-1)	5.674 (-4)	6.153 (-6)	3.164 (-8)	2.915 (-4)	2.234 (-4)	9.639 (-5)	1.055 (-8)

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

Altitude: 270,000 feet

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000													
3000													
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)	5.028 (-6)	8.023 (-25)	2.643 (-11)							
5000	7.808 (-1)	2.097 (-1)	9.324 (-3)	2.264 (-4)	3.246 (-16)	8.660 (-7)							
6000	7.796 (-1)	2.084 (-1)	9.322 (-3)	2.231 (-3)	4.878 (-11)	4.424 (-4)							
7000	7.719 (-1)	1.980 (-1)	9.263 (-3)	7.719 (-3)	3.494 (-8)	1.817 (-2)							
8000	7.532 (-1)	1.704 (-1)	9.069 (-3)	1.266 (-2)	6.569 (-7)	5.467 (-2)							
9000	7.290 (-1)	1.336 (-1)	8.797 (-3)	1.556 (-2)	3.561 (-6)	1.130 (-1)							
10,000	7.025 (-1)	9.299 (-2)	8.488 (-3)	1.663 (-2)	1.292 (-5)	1.793 (-1)							
11,000	6.761 (-1)	5.180 (-2)	8.167 (-3)	1.568 (-2)	4.819 (-5)	2.482 (-1)							
12,000	6.532 (-1)	1.545 (-2)	7.870 (-3)	1.364 (-2)	2.295 (-4)	3.116 (-1)							
13,000	6.417 (-1)	8.577 (-4)	7.716 (-3)	9.774 (-3)	9.280 (-3)	3.407 (-1)							
14,000	6.197 (-1)	1.097 (-4)	7.598 (-3)	2.454 (-3)	3.089 (-2)	3.393 (-1)							
15,000	5.834 (-1)	5.254 (-5)	7.425 (-3)	1.776 (-3)	7.499 (-2)	3.322 (-1)	3.889 (-5)	7.002 (-9)	2.650 (-9)	3.872 (-5)	1.351 (-8)	1.488 (-7)	1.345 (-8)
16,000	5.414 (-1)	2.381 (-5)	7.226 (-3)	1.433 (-3)	1.262 (-1)	3.236 (-1)	6.162 (-5)	2.822 (-8)	4.054 (-9)	6.102 (-5)	8.547 (-8)	4.847 (-7)	1.640 (-8)
17,000	4.966 (-1)	1.559 (-5)	7.015 (-3)	1.208 (-3)	1.806 (-1)	3.144 (-1)	8.584 (-5)	7.655 (-8)	5.551 (-9)	8.389 (-5)	3.244 (-7)	1.145 (-6)	2.010 (-8)
18,000	4.506 (-1)	1.107 (-5)	6.799 (-3)	1.037 (-3)	2.366 (-1)	3.048 (-1)	1.103 (-4)	1.670 (-7)	7.146 (-9)	1.069 (-4)	9.341 (-7)	2.275 (-6)	2.861 (-8)
19,000	4.041 (-1)	8.237 (-6)	6.581 (-3)	8.983 (-4)	2.930 (-1)	2.951 (-1)	1.363 (-4)	3.175 (-7)	8.843 (-9)	1.296 (-4)	2.269 (-6)	4.070 (-6)	2.790 (-8)
20,000	3.579 (-1)	6.312 (-6)	6.364 (-3)	7.792 (-4)	3.493 (-1)	2.854 (-1)	1.640 (-4)	5.491 (-7)	1.065 (-8)	1.517 (-4)	4.927 (-6)	6.796 (-6)	2.031 (-8)
21,000	3.121 (-1)	4.922 (-6)	6.149 (-3)	6.738 (-4)	4.048 (-1)	2.758 (-1)	1.943 (-4)	8.855 (-7)	1.256 (-8)	1.727 (-4)	9.897 (-6)	1.084 (-5)	2.864 (-8)
22,000	2.672 (-1)	3.875 (-6)	5.938 (-3)	5.784 (-4)	4.594 (-1)	2.664 (-1)	2.288 (-4)	1.352 (-6)	1.458 (-8)	1.919 (-4)	1.883 (-5)	1.676 (-5)	2.711 (-8)
23,000	2.234 (-1)	3.059 (-6)	5.732 (-3)	4.907 (-4)	5.126 (-1)	2.572 (-1)	2.700 (-4)	1.974 (-6)	1.670 (-8)	2.081 (-4)	3.452 (-5)	2.543 (-5)	4.095 (-8)
24,000	1.810 (-1)	2.404 (-6)	5.533 (-3)	4.088 (-4)	5.641 (-1)	2.483 (-1)	3.229 (-4)	2.768 (-6)	1.888 (-8)	2.200 (-4)	6.189 (-5)	3.824 (-5)	4.554 (-8)
25,000	1.401 (-1)	1.866 (-6)	5.341 (-3)	3.313 (-4)	6.137 (-1)	2.397 (-1)	3.969 (-4)	3.739 (-6)	2.106 (-8)	2.253 (-4)	1.102 (-4)	5.770 (-5)	5.157 (-8)
26,000	1.012 (-1)	1.409 (-6)	5.158 (-3)	2.568 (-4)	6.609 (-1)	2.315 (-1)	5.136 (-4)	4.851 (-6)	2.316 (-8)	2.211 (-4)	1.957 (-4)	8.881 (-5)	6.017 (-8)

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

Altitude: 280,000 feet

MOLE FRACTION CONCENTRATIONS

V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000													
3000													
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)	5.028 (-6)	1.090 (-24)	3.589 (-11)							
5000	7.808 (-1)	2.097 (-1)	9.324 (-3)	2.269 (-4)	4.408 (-16)	1.176 (-6)							
6000	7.785 (-1)	2.083 (-1)	9.321 (-3)	2.221 (-3)	6.478 (-11)	5.936 (-4)							
7000	7.711 (-1)	1.966 (-1)	9.251 (-3)	7.350 (-3)	3.733 (-8)	1.569 (-2)							
8000	7.517 (-1)	1.678 (-1)	9.046 (-3)	1.165 (-2)	6.009 (-7)	5.972 (-2)							
9000	7.272 (-1)	1.305 (-1)	8.767 (-3)	1.612 (-2)	3.080 (-6)	1.194 (-1)							
10,000	7.007 (-1)	8.963 (-2)	8.455 (-3)	1.894 (-2)	1.097 (-5)	1.863 (-1)							
11,000	6.742 (-1)	6.239 (-2)	8.133 (-3)	1.989 (-2)	3.793 (-5)	2.553 (-1)							
12,000	6.517 (-1)	4.267 (-2)	7.842 (-3)	1.954 (-2)	1.144 (-4)	3.177 (-1)							
13,000	6.409 (-1)	3.302 (-2)	7.705 (-3)	1.872 (-2)	3.173 (-4)	3.620 (-1)							
14,000	6.170 (-1)	2.364 (-2)	7.583 (-3)	1.834 (-2)	8.423 (-4)	3.392 (-1)							
15,000	5.797 (-1)	2.978 (-2)	7.406 (-3)	1.817 (-2)	7.959 (-2)	3.918 (-1)	3.692 (-5)	6.066 (-9)	1.935 (-9)	3.676 (-5)	1.322 (-8)	1.433 (-7)	7.167 (-10)
16,000	5.371 (-1)	1.697 (-2)	7.205 (-3)	1.150 (-3)	1.318 (-1)	3.230 (-1)	5.752 (-5)	2.333 (-8)	2.923 (-9)	5.696 (-5)	7.882 (-8)	4.497 (-7)	9.878 (-10)
17,000	4.921 (-1)	1.121 (-2)	6.993 (-3)	9.711 (-4)	1.862 (-1)	3.135 (-1)	7.900 (-5)	6.173 (-8)	3.976 (-9)	7.760 (-5)	2.900 (-7)	1.092 (-6)	1.185 (-8)
18,000	4.459 (-1)	8.003 (-3)	6.776 (-3)	8.351 (-4)	2.923 (-1)	3.030 (-1)	1.013 (-4)	1.326 (-7)	5.098 (-9)	9.831 (-5)	8.197 (-7)	2.047 (-6)	1.342 (-8)
19,000	3.994 (-1)	5.976 (-3)	6.558 (-3)	7.235 (-4)	3.988 (-1)	2.943 (-1)	1.247 (-4)	2.497 (-7)	6.296 (-9)	1.188 (-4)	1.969 (-6)	3.636 (-6)	1.532 (-8)
20,000	3.531 (-1)	4.587 (-3)	6.341 (-3)	6.274 (-4)	3.551 (-1)	2.846 (-1)	1.495 (-4)	4.290 (-7)	7.575 (-9)	1.388 (-4)	4.245 (-6)	6.050 (-6)	1.717 (-8)
21,000	3.074 (-1)	3.580 (-3)	6.126 (-3)	5.422 (-4)	4.106 (-1)	2.750 (-1)	1.766 (-4)	6.891 (-7)	8.940 (-9)	1.577 (-4)	8.498 (-6)	9.636 (-6)	1.903 (-8)
22,000	2.625 (-1)	2.819 (-3)	5.916 (-3)	4.649 (-4)	4.651 (-1)	2.655 (-1)	2.072 (-4)	1.050 (-6)	1.039 (-8)	1.751 (-4)	1.616 (-5)	1.491 (-5)	2.096 (-8)
23,000	2.188 (-1)	2.223 (-3)	5.710 (-3)	3.967 (-4)	5.183 (-1)	2.564 (-1)	2.439 (-4)	1.532 (-6)	1.193 (-8)	1.900 (-4)	2.968 (-5)	2.269 (-5)	2.304 (-8)
24,000	1.784 (-1)	1.744 (-3)	5.511 (-3)	3.370 (-4)	5.697 (-1)	2.474 (-1)	2.810 (-4)	2.151 (-6)	1.353 (-8)	2.010 (-4)	5.348 (-5)	3.432 (-5)	2.562 (-8)
25,000	1.356 (-1)	1.349 (-3)	5.319 (-3)	2.838 (-4)	6.193 (-1)	2.389 (-1)	3.572 (-4)	2.912 (-6)	1.517 (-8)	2.061 (-4)	8.602 (-5)	5.224 (-5)	2.887 (-8)
26,000	9.666 (-2)	1.012 (-3)	5.136 (-3)	2.028 (-4)	6.664 (-1)	2.307 (-1)	4.631 (-4)	3.780 (-6)	1.677 (-8)	2.021 (-4)	1.757 (-4)	8.151 (-5)	3.393 (-8)

Altitude:290,000 feet

TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

MOLE FRACTION CONCENTRATIONS

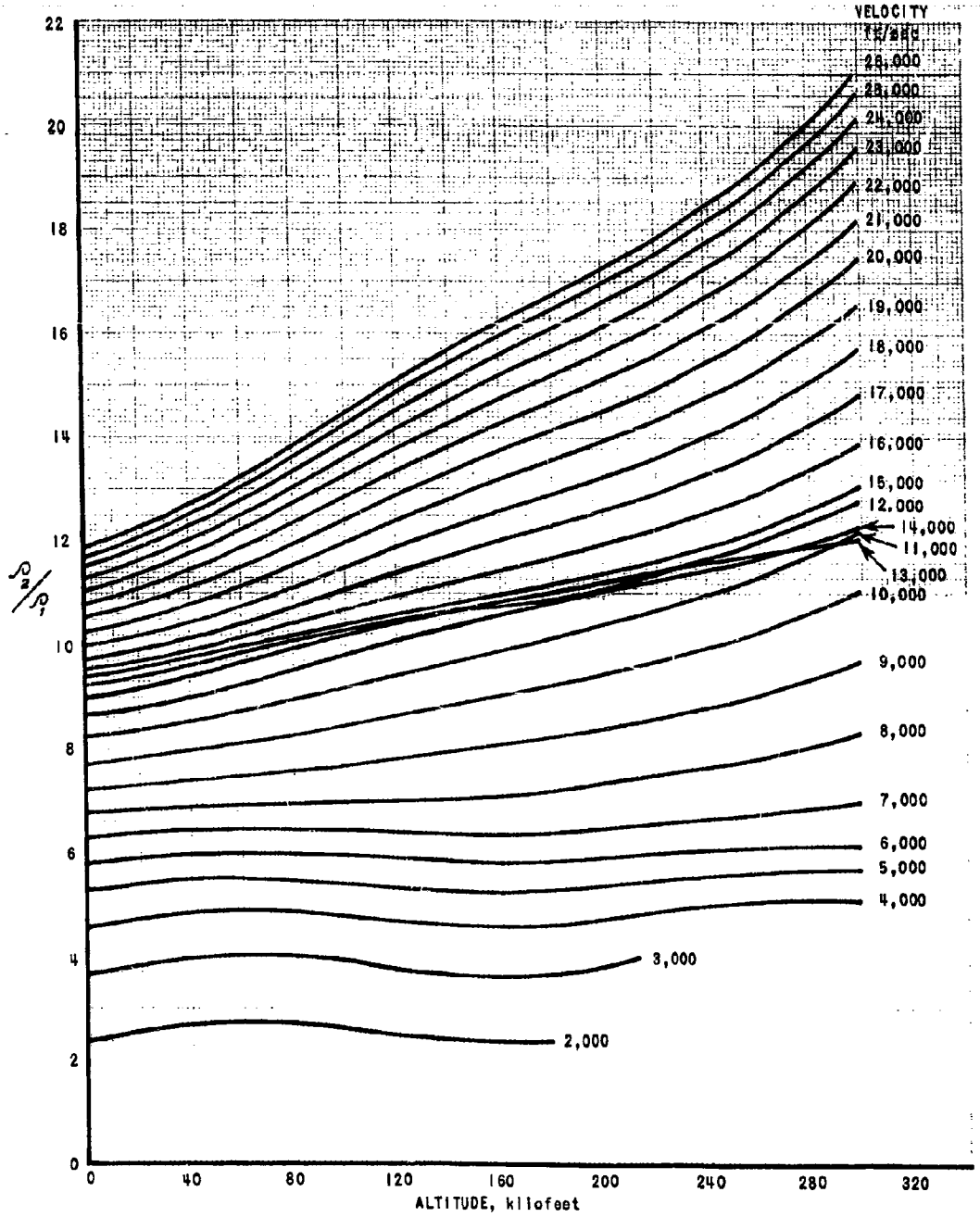
V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000													
3000													
4000	7.809 (-1)	2.098 (-1)	9.324 (-3)	5.028 (-6)	1.479 (-24)	4.873 (-11)							
5000	7.808 (-1)	2.097 (-1)	9.324 (-3)	2.263 (-4)	5.984 (-16)	1.597 (-6)							
6000	7.795 (-1)	2.082 (-1)	9.320 (-3)	2.208 (-3)	8.540 (-11)	7.933 (-4)							
7000	7.702 (-1)	1.952 (-1)	9.236 (-3)	6.963 (-3)	3.884 (-8)	1.842 (-2)							
8000	7.502 (-1)	1.653 (-1)	9.022 (-3)	1.070 (-2)	5.421 (-7)	6.475 (-2)							
9000	7.255 (-1)	1.275 (-1)	8.739 (-3)	1.279 (-2)	2.643 (-6)	1.255 (-1)							
10.000	6.988 (-1)	8.637 (-2)	8.424 (-3)	1.340 (-2)	9.265 (-6)	1.930 (-1)							
11.000	6.726 (-1)	4.510 (-2)	8.102 (-3)	1.229 (-2)	3.250 (-5)	2.621 (-1)							
12.000	6.504 (-1)	1.012 (-2)	7.816 (-3)	8.273 (-3)	2.088 (-4)	3.232 (-1)							
13.000	6.400 (-1)	3.268 (-4)	7.696 (-3)	2.820 (-3)	6.264 (-3)	3.429 (-1)							
14.000	6.143 (-1)	4.980 (-5)	7.568 (-3)	1.528 (-3)	3.765 (-2)	3.390 (-1)							
15.000	5.760 (-1)	2.094 (-5)	7.387 (-3)	1.133 (-3)	8.412 (-2)	3.312 (-1)	3.493 (-5)	5.204 (-9)	1.409 (-9)	3.478 (-5)	1.276 (-8)	1.369 (-7)	4.118 (-10)
16.000	5.330 (-1)	1.214 (-5)	7.185 (-3)	9.233 (-4)	1.365 (-1)	3.223 (-1)	5.358 (-5)	1.917 (-8)	2.104 (-9)	5.308 (-5)	7.204 (-8)	4.149 (-7)	5.855 (-10)
17.000	4.877 (-1)	8.087 (-6)	6.972 (-3)	7.816 (-4)	1.915 (-1)	3.129 (-1)	7.296 (-5)	4.956 (-8)	2.844 (-9)	7.170 (-5)	2.575 (-7)	9.440 (-7)	6.516 (-10)
18.000	4.414 (-1)	5.800 (-6)	6.755 (-3)	6.729 (-4)	2.478 (-1)	3.032 (-1)	9.303 (-5)	1.050 (-7)	3.635 (-9)	9.037 (-5)	7.155 (-7)	1.835 (-6)	7.621 (-10)
19.000	3.949 (-1)	4.344 (-6)	6.536 (-3)	5.831 (-4)	3.043 (-1)	2.934 (-1)	1.140 (-4)	1.958 (-7)	4.480 (-9)	1.088 (-4)	1.701 (-6)	3.240 (-6)	8.686 (-10)
20.000	3.486 (-1)	3.340 (-6)	6.319 (-3)	5.057 (-4)	3.606 (-1)	2.837 (-1)	1.362 (-4)	3.344 (-7)	5.387 (-9)	1.268 (-4)	3.643 (-6)	5.372 (-6)	9.722 (-10)
21.000	3.029 (-1)	2.609 (-6)	6.105 (-3)	4.367 (-4)	4.161 (-1)	2.741 (-1)	1.604 (-4)	5.351 (-7)	6.359 (-9)	1.440 (-4)	7.269 (-6)	8.547 (-6)	1.076 (-9)
22.000	2.581 (-1)	2.054 (-6)	5.894 (-3)	3.741 (-4)	4.706 (-1)	2.647 (-1)	1.877 (-4)	8.138 (-7)	7.402 (-9)	1.598 (-4)	1.381 (-5)	1.324 (-5)	1.183 (-9)
23.000	2.148 (-1)	1.619 (-6)	5.689 (-3)	3.162 (-4)	5.236 (-1)	2.555 (-1)	2.203 (-4)	1.187 (-6)	8.516 (-9)	1.735 (-4)	2.542 (-5)	2.021 (-5)	1.300 (-9)
24.000	1.721 (-1)	1.268 (-6)	5.491 (-3)	2.619 (-4)	5.751 (-1)	2.466 (-1)	2.622 (-4)	1.668 (-6)	9.696 (-9)	1.837 (-4)	4.605 (-5)	3.074 (-5)	1.440 (-9)
25.000	1.310 (-1)	9.769 (-7)	5.299 (-3)	2.102 (-4)	6.245 (-1)	2.381 (-1)	3.215 (-4)	2.265 (-6)	1.092 (-8)	1.886 (-4)	8.343 (-5)	4.720 (-5)	1.626 (-9)
26.000	9.249 (-2)	7.285 (-7)	5.116 (-3)	1.603 (-4)	6.716 (-1)	2.298 (-1)	4.175 (-4)	2.959 (-6)	1.215 (-8)	1.849 (-4)	1.550 (-4)	7.468 (-5)	1.908 (-9)

Altitude: 300,000 feet

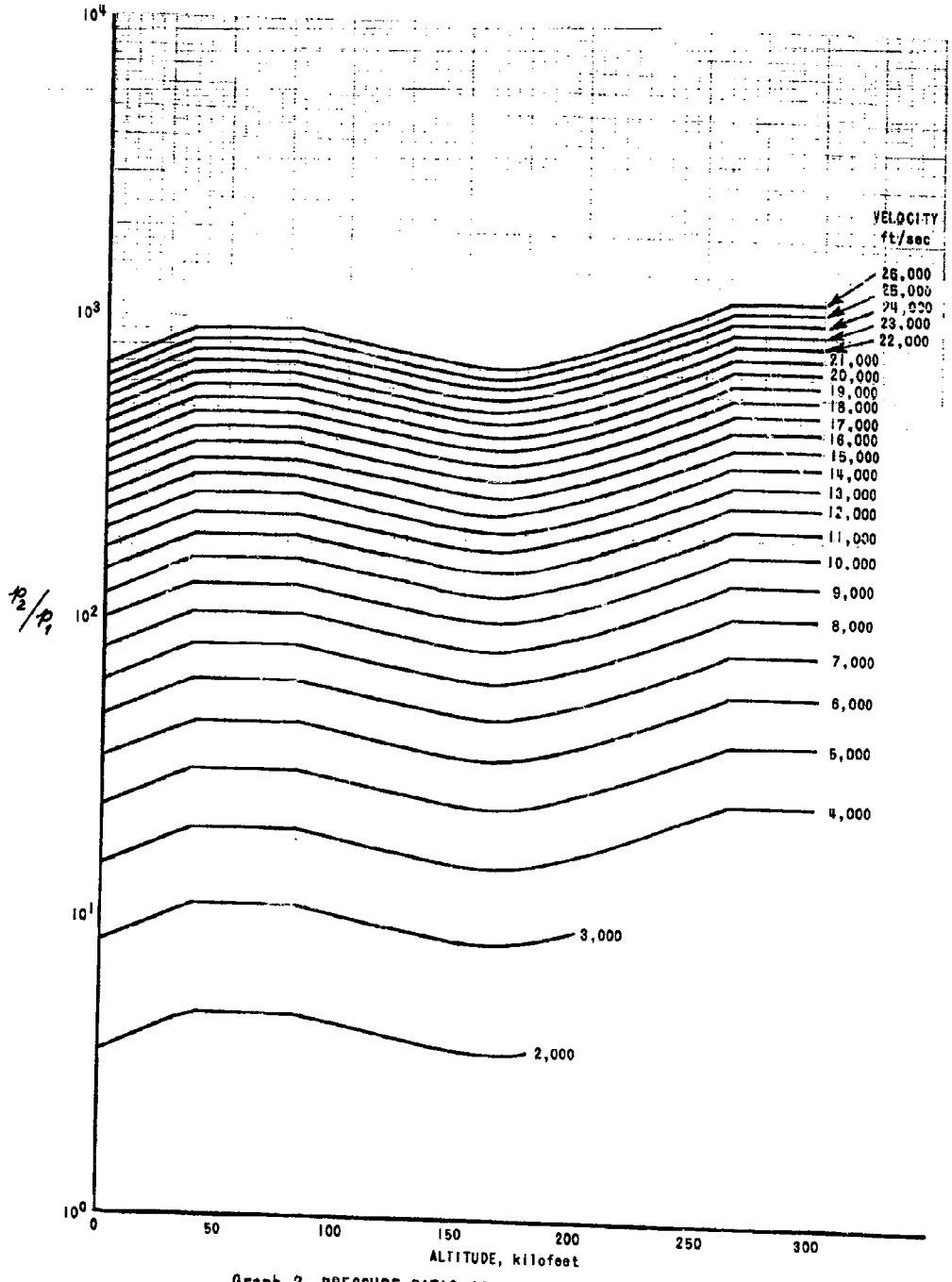
TABLE III - GAS COMPOSITION BEHIND NORMAL-SHOCK WAVE

MOLE FRACTION CONCENTRATIONS

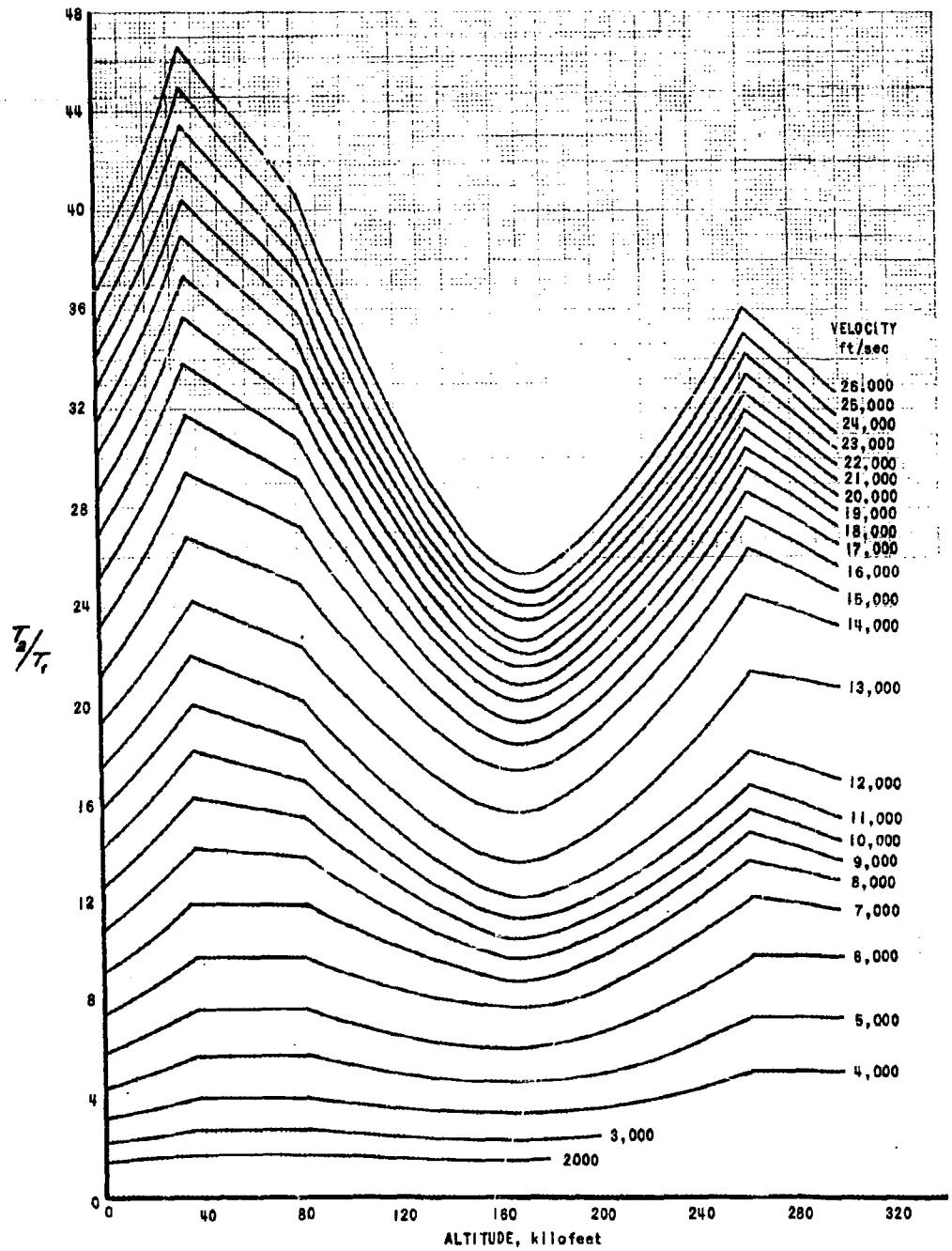
V_1	N_2	O_2	A	NO	N	O	e	N_2^+	O_2^+	NO^+	N^+	O^+	O^-
2000													
3000													
4000	7.808 (-1)	2.098 (-1)	9.324 (-3)	5.064 (-6)	2.087 (-24)	6.756 (-11)							
5000	7.808 (-1)	2.097 (-1)	9.324 (-3)	2.271 (-4)	8.279 (-16)	2.191 (-6)							
6000	7.796 (-1)	2.081 (-1)	9.319 (-3)	2.195 (-3)	1.126 (-10)	1.061 (-3)							
7000	7.692 (-1)	1.936 (-1)	9.224 (-3)	6.564 (-3)	3.953 (-8)	2.139 (-2)							
8000	7.487 (-1)	1.627 (-1)	8.999 (-3)	9.800 (-3)	4.832 (-7)	6.979 (-2)							
9000	7.237 (-1)	1.248 (-1)	8.711 (-3)	1.156 (-2)	2.251 (-6)	1.315 (-1)							
10,000	6.970 (-1)	8.316 (-2)	8.394 (-3)	1.200 (-2)	7.789 (-6)	1.994 (-1)							
11,000	6.706 (-1)	4.189 (-2)	8.072 (-3)	1.085 (-2)	2.782 (-5)	2.686 (-1)							
12,000	6.491 (-1)	7.828 (-3)	7.793 (-3)	6.864 (-3)	2.087 (-4)	3.282 (-1)							
13,000	6.390 (-1)	2.014 (-4)	7.688 (-3)	2.164 (-3)	7.540 (-3)	3.434 (-1)							
14,000	6.116 (-1)	3.385 (-5)	7.553 (-3)	1.208 (-3)	4.114 (-2)	3.386 (-1)							
15,000	5.724 (-1)	1.476 (-5)	7.369 (-3)	9.053 (-4)	8.859 (-2)	3.307 (-1)	5.295 (-5)	4.423 (-9)	1.023 (-9)	3.280 (-5)	1.218 (-8)	1.297 (-7)	2.856 (-10)
16,000	5.290 (-1)	8.689 (-6)	7.165 (-3)	7.413 (-4)	1.414 (-1)	3.216 (-1)	4.982 (-5)	1.566 (-8)	1.510 (-9)	4.936 (-5)	6.531 (-8)	3.608 (-7)	3.046 (-10)
17,000	4.835 (-1)	5.836 (-6)	6.951 (-3)	6.289 (-4)	1.957 (-1)	3.121 (-1)	8.728 (-5)	3.959 (-8)	2.029 (-9)	6.616 (-5)	2.272 (-7)	8.518 (-7)	3.684 (-10)
18,000	4.371 (-1)	4.205 (-6)	6.734 (-3)	5.420 (-4)	2.530 (-1)	3.024 (-1)	8.532 (-5)	8.275 (-8)	2.585 (-9)	8.298 (-5)	3.213 (-7)	1.640 (-6)	4.213 (-10)
19,000	3.906 (-1)	3.158 (-6)	6.515 (-3)	4.699 (-4)	3.096 (-1)	2.926 (-1)	1.041 (-4)	1.530 (-7)	3.181 (-9)	9.962 (-5)	1.462 (-6)	2.878 (-6)	4.987 (-10)
20,000	3.443 (-1)	2.433 (-6)	6.298 (-3)	4.074 (-4)	3.659 (-1)	2.829 (-1)	1.260 (-4)	2.599 (-7)	3.822 (-9)	1.159 (-4)	3.113 (-6)	4.757 (-6)	5.486 (-10)
21,000	2.986 (-1)	1.902 (-6)	6.084 (-3)	3.516 (-4)	4.214 (-1)	2.733 (-1)	1.456 (-4)	4.143 (-7)	4.514 (-9)	1.314 (-4)	6.192 (-6)	7.559 (-6)	6.062 (-10)
22,000	2.538 (-1)	1.497 (-6)	5.874 (-3)	3.009 (-4)	4.758 (-1)	2.639 (-1)	1.700 (-4)	6.290 (-7)	5.261 (-9)	1.458 (-4)	1.176 (-5)	1.172 (-5)	6.655 (-10)
23,000	2.102 (-1)	1.179 (-6)	5.659 (-3)	2.539 (-4)	5.288 (-1)	2.547 (-1)	1.989 (-4)	9.172 (-7)	6.068 (-9)	1.583 (-4)	2.170 (-5)	1.795 (-5)	7.388 (-10)
24,000	1.679 (-1)	9.217 (-7)	5.471 (-3)	2.097 (-4)	5.801 (-1)	2.458 (-1)	2.362 (-4)	1.291 (-6)	6.834 (-9)	1.679 (-4)	3.950 (-5)	2.765 (-6)	8.073 (-10)
25,000	1.272 (-1)	7.077 (-7)	5.280 (-3)	1.675 (-4)	6.295 (-1)	2.372 (-1)	2.891 (-4)	1.758 (-6)	7.849 (-9)	1.726 (-4)	7.222 (-5)	4.255 (-5)	9.097 (-10)
26,000	8.840 (-2)	5.243 (-7)	5.098 (-3)	1.266 (-4)	6.766 (-1)	2.290 (-1)	3.761 (-4)	2.305 (-6)	8.785 (-9)	1.693 (-4)	1.362 (-4)	6.832 (-5)	1.067 (-9)



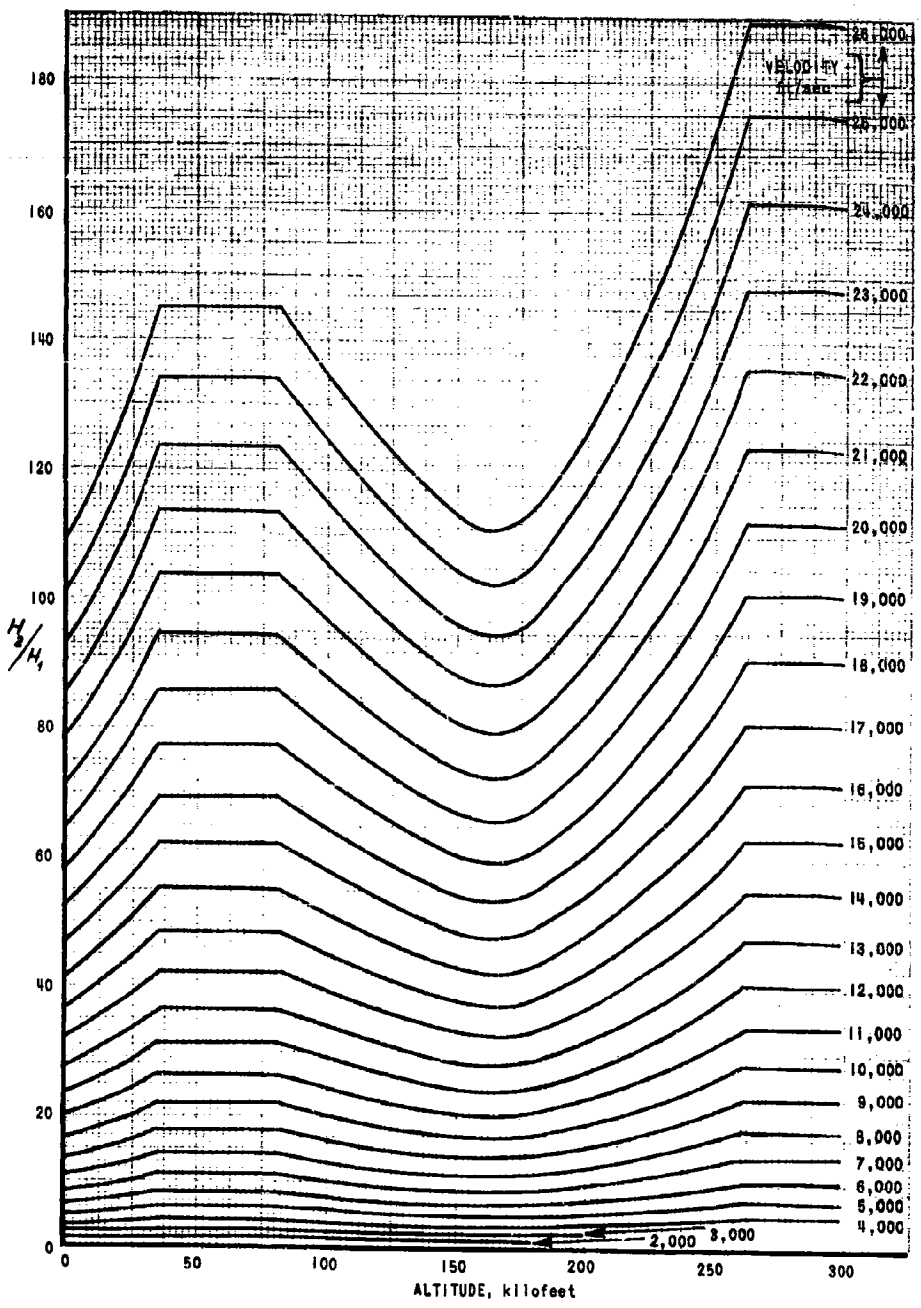
Graph I DENSITY RATIO AS A FUNCTION OF ALTITUDE



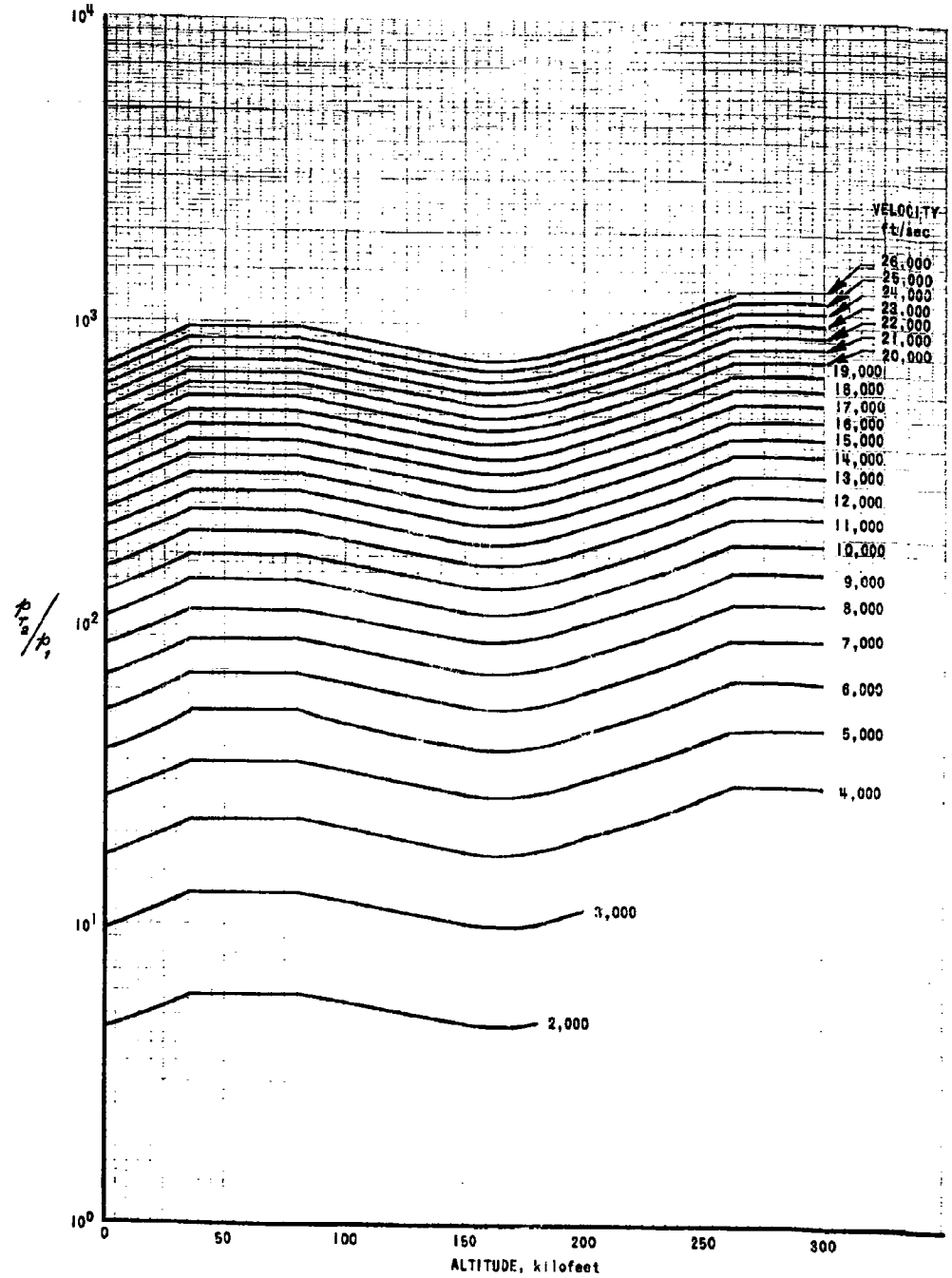
Graph 2 PRESSURE RATIO AS A FUNCTION OF ALTITUDE



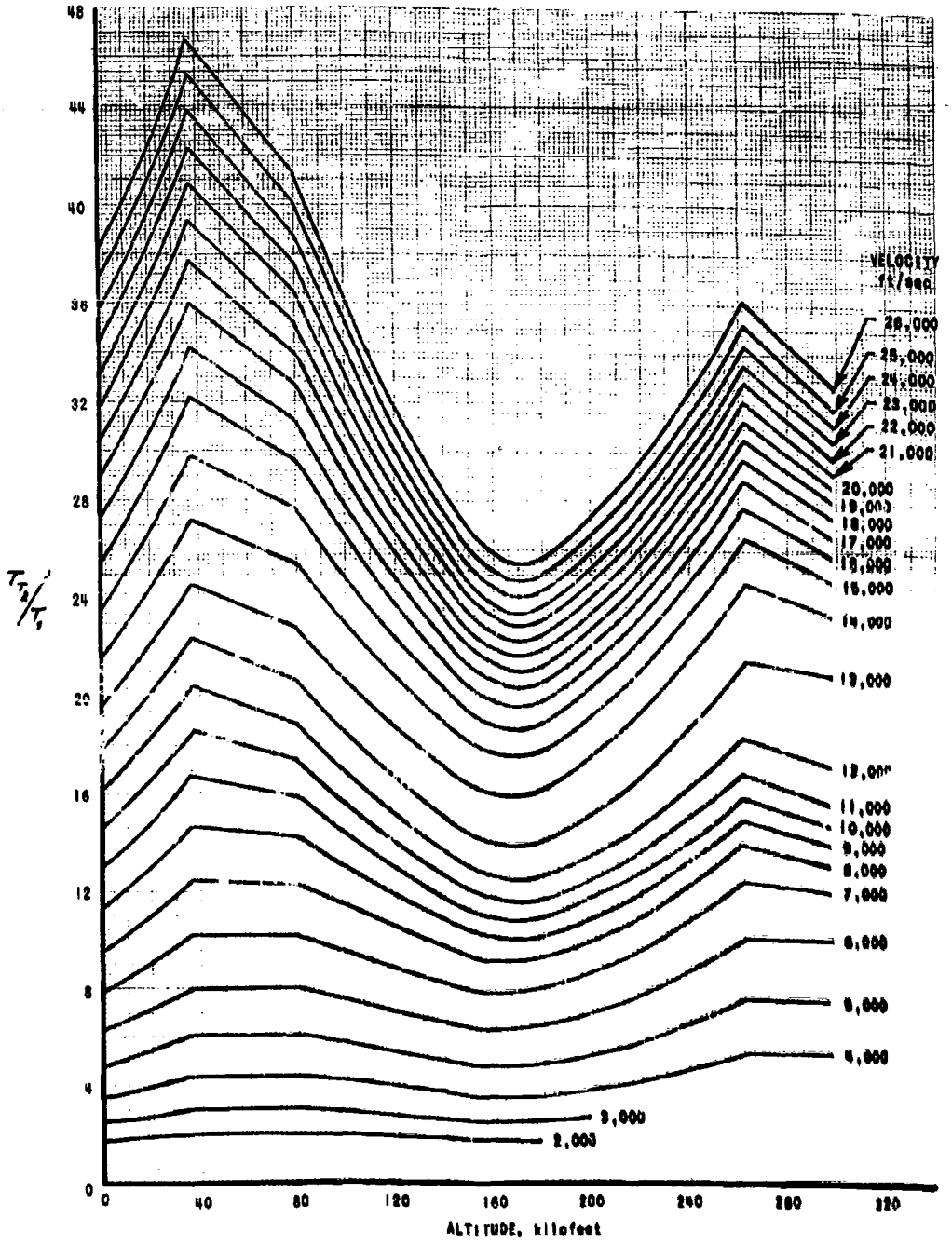
Graph 3 TEMPERATURE RATIO AS A FUNCTION OF ALTITUDE



Graph 4 ENTHALPY RATIO AS A FUNCTION OF ALTITUDE



Graph 5 STAGNATION-POINT PRESSURE RATIO AS A FUNCTION OF ALTITUDE



Graph 6 STAGNATION-POINT TEMPERATURE AS A FUNCTION OF ALTITUDE